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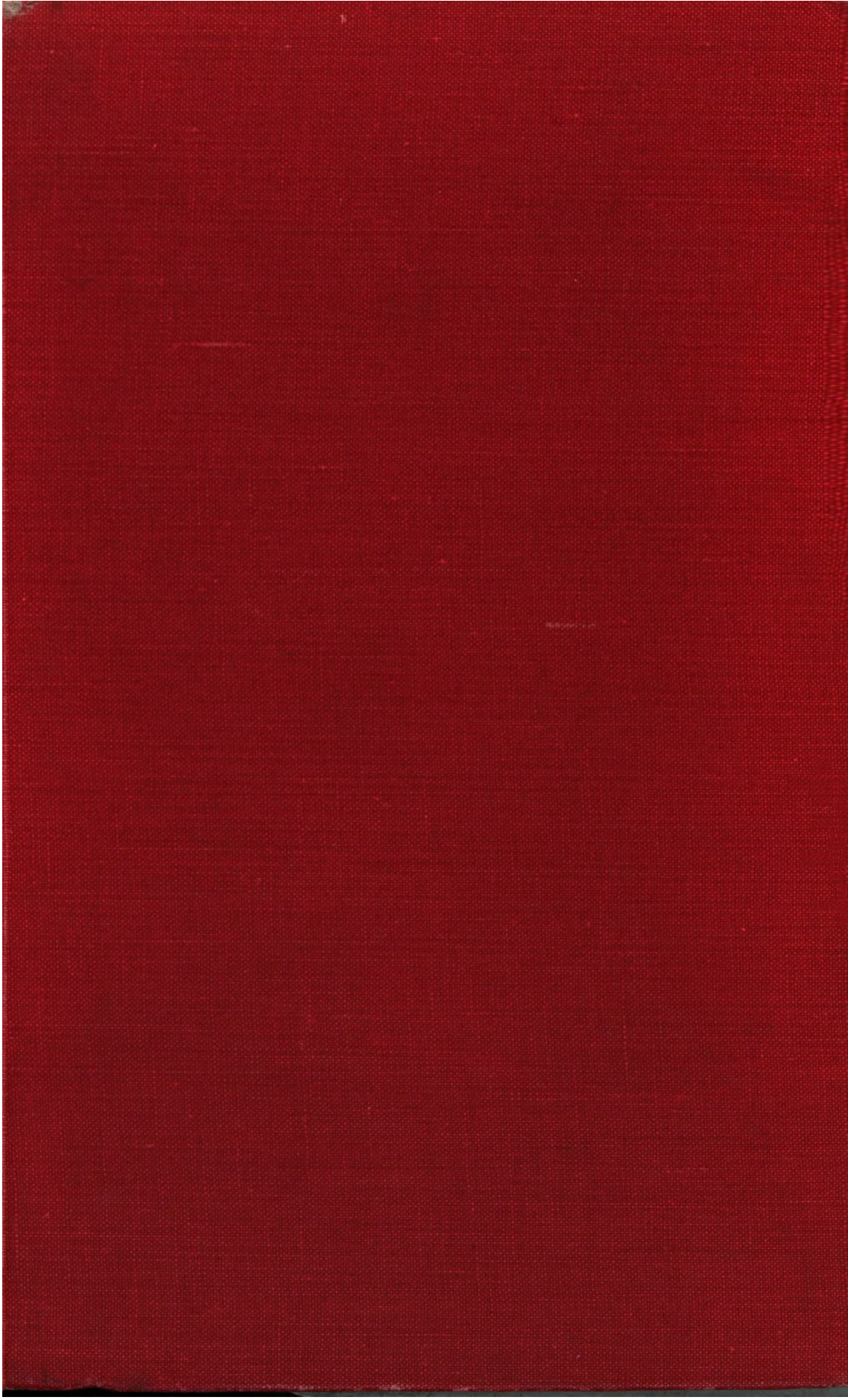

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NEW ZEALAND
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BULLETIN 130

THE EARTHWORM FAUNA OF NEW ZEALAND

By K. E. LEE
Soil Bureau

WELLINGTON
1959

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FOREWORD

To help in the solving of New Zealand's soil problems – important alike to agriculture and forestry – a biology division was established within the Soil Bureau, DSIR, in 1947. Its purpose was the study of the biological properties of our soils and the part living organisms played in soil processes. In 1949, as part of this programme, an earthworm survey was commenced, and this bulletin summarises the information gathered.

Since at least 48 per cent of the native species have not previously been described, the bulletin is, in large part, devoted to descriptions of species, genera, and larger taxonomic units of New Zealand earthworms. It contains in addition, however, sections on earthworm distribution and ecology. In these sections, an important step forward is taken in that the biological information is related to information on the distribution, characteristics, and processes of New Zealand soils.

The basic information here set out paves the way for more detailed studies of the activities and metabolic processes of earthworms, and their effects on the soil. It should stimulate interest not only in this field but also in the overall study of our soil fauna of which, as yet, too little is known.

N. H. TAYLOR, Director, Soil Bureau.

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In the course of the field work and preparation leading to this monograph, assistance has been received from many people, too numerous for each to be mentioned. The assistance of those who have collected specimens is acknowledged in the collection records following the description of each species.

I am particularly grateful to Professor L. R. Richardson, of Victoria University College, who first aroused my interest in New Zealand earthworms and guided my first attempts at systematic work, to the late Sir William Benham, who assisted me with advice and the loan of literature until his death in 1950, to Mr N. H. Taylor, Director of N.Z. Soil Bureau, and his predecessor, Dr L. I. Grange, for their guidance and advice as the work has progressed.

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Dr R. R. Forster, former assistant director of Canterbury Museum, placed the Museum's extensive collection of earthworms at my disposal, and Mr E. G. Turbott, of Auckland War Memorial Museum, lent me the collections of his museum. Mr J. S. Edwards has made extensive collections from off-shore islands around the Auckland coast and from the mainland near Auckland and has provided ecological notes concerning the species collected.

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THE EARTHWORM FAUNA OF NEW ZEALAND

ABSTRACT

This study is based on about 7,000 specimens of earthworms, collected from the mainland of New Zealand and its outlying islands, Kermadec Is., Snares Is., Campbell Is., Auckland Is., Antipodes Is., Macquarie Id., and Chatham Is. Previous work on New Zealand earthworms is reviewed, and where necessary revised.

192 species of earthworms, belonging to 34 genera, are recognised. Of these, 178 species, of 27 genera, are referred to the family Megascolecidae, and 14 species, of 7 genera, to the family Lumbricidae. Diagnoses and keys are given for all species, genera, tribes, subfamilies and families within the fauna. To aid in the identification of species and to enable comparisons between species to be made, the principal morphological characters of the species of all genera with two or more New Zealand species have been tabulated.

The classification of Megascolecidae is reviewed and two subfamilies, Acanthodrilinae and Megascolecinae, are recognised, in place of the four subfamilies formerly recognised. The general morphology of Megascolecidae is described and figured and the taxonomic characters of genera and species of Megascolecidae and Lumbricidae are discussed. Wherever possible, the current diagnoses of megascolecid genera have been amplified, and where necessary modified. Four new genera and 53 new species of Megascolecidae are described. The geographical distribution of megascolecid species is mapped, and the taxonomic relationships of the genera and species are discussed.

The mainland of New Zealand is divided into nine major areas, based on the distribution of Megascolecidae. The fauna of each area and of outlying islands is listed and the relationships of groups of species within individual areas and in adjacent areas and groups of islands are discussed. Differences between the areas are explained in terms of current ideas of the geological, climatic and vegetational history of the New Zealand region. Evidence for geographical speciation is discussed.

Various theories of the origin of New Zealand Megascolecidae are discussed and it is concluded that on the evidence of known distribution it is most likely that New Zealand earthworms came originally from the Indo-Malayan or Australian region and entered New Zealand across a land connection from the north. Megascolecinae may have arrived during Tertiary times and Acanthodrilinae during the Cretaceous period. It is concluded that the earthworm faunas of New Zealand subantarctic islands are of recent origin and that the faunas of Campbell and Antipodes Is. have been derived very recently from the fauna of Auckland Is.

The environmental conditions necessary for the survival of earthworms are defined and the habitats in which New Zealand species have been found are classified and their characteristics examined in the light of the conditions listed as necessary. The distribution and ecology of New Zealand earthworms are examined first in relation to the distribution and characteristics of the major New Zealand soil groups defined by Taylor (1948) and secondly in relation to each of the five environmental factors considered by Taylor to comprise the significant causal agents of soil formation. Evidence for ecological speciation is discussed.

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Part One

INTRODUCTION

This monograph arises out of a survey of the earthworm fauna of New Zealand soils, undertaken by the author in 1949 and completed in 1955, as a research project of the New Zealand Soil Bureau. The original aim of the project was to attempt to relate the distribution of New Zealand earthworms to the distribution of the various soil groups of New Zealand and to evaluate their contribution to soil forming processes. Comprehensive collecting of specimens, followed by identification, revealed many new species of endemic Megascolecidae, and the systematic description of these species, together with a re-examination of type and named material of previously described species, has resulted in a re-appraisal of the taxonomy of the family and led to some revision of the classification.

The earliest description of a New Zealand earthworm was that of *Hypogaeon orthostichon* (Schmarda, 1861). Ten years later Baird (1871) described a second species, *Megascolex antarcticus*. These species are listed as *species incertae sedis* since neither of them is sufficiently described for certain identification and the type specimens have not been re-examined. Hutton (1877) described six species of New Zealand earthworms from the collections of Otago Museum and later (1883 and again in 1904) listed the species of New Zealand worms known at the time.

Between the years 1885 and 1900, Beddard, in a long series of papers published for the most part in Proceedings of the Zoological Society of London and Quarterly Journal of Microscopical Science, described species and genera of New Zealand Megascolecidae. Beddard's work placed the study of New Zealand earthworms on a sound scientific basis. His systematic descriptions were detailed and well illustrated and have not needed extensive revision as knowledge of the fauna has increased. Beddard (1895a) published a monograph of the order Oligochaeta, in which he gave short descriptions of all the species known at that time. He included 24 species (3 listed as *species incertae sedis*) from New Zealand. (This number does not include introduced lumbricids.) Most of Beddard's specimens were collected by W. W. Smith, whose papers in the Transactions of the New Zealand Institute (1887, 1893, 1894) summarised Beddard's published descriptions and included Smith's observations on the habits of the species described. Other specimens were sent to Beddard by Professor T. J. Parker.

The attention to detail characteristic of Beddard's systematic descriptions appears to have exerted a strong influence on the technique adopted by his contemporaries in their published descriptions.

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Benham, who contributed more to the literature of New Zealand earthworm systematics than any other worker, published his first paper on New Zealand Megascolecidae in 1891 and continued publication of systematic papers up to 1949. A few of his early papers were published in Quarterly Journal of Microscopical Science, but from 1901 onwards nearly all his papers were published in Transactions of the New Zealand Institute and its successor, Transactions of the Royal Society of New Zealand. Benham's early systematic descriptions (up to 1909) were modelled on the style of Beddard. Subsequently Benham tended to reduce the detail contained in his descriptions, probably as a result of the influence of the systematic techniques of Michaelsen and Stephenson.

Ude, who published a long paper including descriptions of New Zealand Megascolecidae in 1905, followed the technique of Beddard, providing very detailed illustrated accounts of the species he described.

With the publication of Volume 10 (Oligochaeta) of Das Tierreich in 1900, Michaelsen established himself as a leading authority on Oligochaeta, with a special interest in Megascolecidae. In this work he gave short diagnoses of all known species of Oligochaeta. He included 31 species (one listed as *species dubiosa*) from New Zealand. (This number excludes introduced lumbricids.) During the subsequent years he developed a system of classification with a strongly empirical basis, which favoured brief systematic descriptions, contrasting with the detailed descriptions of Beddard and his contemporaries. Stephenson followed Michaelsen's taxonomic principles and in the systematic section of "The Oligochaeta" (1930) he gave a full description of the basis of Michaelsen's classification and used it in descriptions of genera and larger subdivisions of Oligochaeta. Michaelsen described some species from New Zealand; his descriptions vary considerably in their attention to detail, sometimes being very short and including mention of only a few characters (e.g., *Maoridrilus intermedius,* described 1923) while others are more detailed (e.g., *Maoridrilus suteri,* described 1922).

Since the work of Beddard, Michaelsen, Stephenson, and Benham ceased, little work has been done on New Zealand earthworms. None of these authors attempted to summarise the state of knowledge of New Zealand earthworms, nor to examine critically the taxonomic status of the many New Zealand species and genera which they described.

In Part 2 (Systematics) of the present work an attempt is made to summarise and examine all the available information on the systematics of New Zealand earthworms. Part 2 is based on the examination and identification of some 7,000 specimens, collected from about 1,200 localities on the mainland of New Zealand and outlying islands. In addition, type specimens and some other specimens named by Benham and Hutton have been re-examined. The classification of Megascolecidae used by Michaelsen and Stephenson fails in some important respects to suit the facts revealed by this study and has consequently been revised. In addition to systematic keys, the principal characters of the species of all genera with two or more New Zealand species have been set out in tables, in the hope that this will provide a ready means of identification of species by the non-specialist.

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The distribution of earthworms in New Zealand has received little attention from previous workers on the fauna. Benham (1902) summarised the distribution of 23 species known to him at that time. In a manuscript dated May 1926, which is in the possession of the author but is not known to have been published, Benham discussed, in general terms, the distribution of the 79 species of 19 genera then known.

In this work, collecting sites for all identified specimens are recorded on distribution maps. From the information so obtained the mainland is divided into nine areas according to the composition of their earthworm faunas. An attempt is made to explain the boundaries between the nine areas with reference to the geological, climatic, and vegetational history of New Zealand. Climatic changes appear to have been most important in determining the distribution pattern in the South Island, while in the North Island recent volcanic activity has been important.

Concerning the origin and route of entry of Megascolecidae into New Zealand there has been much argument. Controversy centred around the constitution of the fauna of subantarctic islands, and particularly on the distribution of a number of species of *Microscolex* (including *M. aucklandicus, M. campbellianus,* and *M. macquariensis*). It had been held by Michaelsen that the "ancestral genus" of all Megascolecidae closely resembled *Microscolex*. Since early work on the New Zealand fauna was concentrated in the South Island, where there is a preponderance of Acanthodrilinae, it was held that the New Zealand fauna could have originated from the south and the fauna of subantarctic islands could be regarded as a relic of the stock from which New Zealand's fauna was derived. Hooker (1853) had first proposed that an extensive land area formerly existed in antarctic regions and that, at a time when this area had a warm climate, areas now widely separated by the ocean had been connected by land and had a common flora. The distribution and relationships of New Zealand earthworms could be interpreted as further evidence in favour of Hooker's hypothesis. Beddard (1895a, 1895c) and Benham (1902, 1909, 1922) were the principal supporters of a southern origin and migration route for New Zealand Megascolecidae. Michaelsen (1896, 1903a, 1903b, 1904, 1905, 1907a, 1911) opposed this view and considered that the archaic earthworm faunas of southern land masses had originated from a common stock in the north and had spread southwards. More recently evolved forms in the north were supposed to have eliminated the archaic forms, which now survive mainly in the extreme south of the land masses. Michaelsen and Benham carried on a controversy in the literature for a number of years.

The climate of opinion among workers on the New Zealand fauna and flora when the argument began favoured southern origins, and this must have influenced Beddard and Benham. Had they been familiar with the earthworm fauna of the northern portion of the North Island, which shows close northern affinities and only very distant southern affinities, their adherence to the hypothesis of a southern origin might have been shaken. Michaelsen's knowledge of Oligochaeta was such that he was able to see the New Zealand Megascolecidae in relation to the Oligochaeta of the whole world, and

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consequently to make a more informed judgment of their affinities than Benham. Michaelsen pointed out that some of the species of *Microscolex* on which the southern migration theory was based are euryhaline, so their distribution across the ocean could be explained by rafting.

The present work supports Michaelsen's point of view. The fauna of New Zealand subantarctic islands has been found to include a few euryhaline species of *Microscolex*, not closely related to any species in the New Zealand mainland fauna but belonging to a group of species with a circum-polar distribution, and a few species, some known to be euryhaline, closely related to the fauna of south-western South Island and probably derived from the mainland fauna. New Zealand Megascolecinae are closely related to those of north-eastern Australia and Indo-Malaya and not to those of any southern land area, while New Zealand Acanthodrilinae are for the most part endemic at the generic level and resemble Indo-Malayan and south-west Pacific genera as closely as they resemble genera from southern lands.

The ecology of New Zealand earthworms has received very little attention from previous workers. Smith (1887, 1893, 1894) published notes on his observations of the habits of Megascolecidae and Lumbricidae, principally in Canterbury. Urquhart (1884, 1887) studied the habits of lumbricids near Auckland, repeating experiments described by Darwin (1881). Apart from the work of Smith and Urquhart, short notes on the habits of species appended to systematic descriptions (e.g., those of Benham, 1903b, 1904a, 1905a) are the only published ecological information. In this work an attempt is made to delineate the environmental conditions necessary for the survival of earthworms, to classify the habitats of New Zealand species and then examine them in the light of the defined requirements. Then, taking the genetic soil classification of Taylor (1948) as a basis, the distribution and ecology of the fauna are examined in relation to the distribution and characteristics of the major groups of New Zealand soils. Superficially it would seem likely that there would be a relationship between taxonomic groups of earthworms and taxonomic groups of soils. However, even though a particular species of earthworm may be specially suited to the environmental conditions prevailing in a particular soil it will not necessarily spread through isolated areas with those environmental conditions unless there is continuity of conditions tolerable to that species between the two areas. The likelihood of the spread of a species under these conditions also depends on the distance to be covered between one area with suitable conditions and another, and upon the availability of some means of transport for the species if the distance is very great, or if there is a physical barrier between one place and another. Those factors of the environment (parent material, climate, topography, biological processes, and time) that influence soil development also affect earthworms, but their effect on earthworms is usually a direct one and is only partly expressed through their effect on the soil. Under similar soil conditions there is a tendency toward the development of earthworm faunas consisting of species similar in their general morphology, physiology and habits, but not necessarily

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identical or even closely related taxonomically. Single factors in the environment (e.g., susceptibility to drought), although they may be relatively unimportant in the soil classification, may be the principal limiting factors for the earthworm population of the soil, and may mask the effects of other factors (e.g., parent material, topography), which may be of considerable importance as soil forming factors. For this reason, each of the soil forming factors (of Taylor, 1948) is taken separately and its relationship to earthworm distribution and ecology is considered.

An attempt has been made in this work to set down all the available information on New Zealand earthworms, together with the author's original work, and to provide a summary and an evaluation of the present state of knowledge of this interesting group of animals.

ABBREVIATIONS USED IN ILLUSTRATIONS

at.	spermathecal atrium	oe. gl.	oesophageal gland
b.v.	blood vessel	o.f.	ovarian funnel
c.g.	cerebral ganglion	p.	prostate
ch.	chaeta	pap.	prostatic papilla
cl.	clitellum	p.d.	prostatic duct
c.m.	copulatory muscles	peri.	peristomium
d.b.v.	dorsal blood vessel	ph.	pharynx
d.div.	duct of spermathecal diverticulum	ph.m.	pharyngeal muscles
		p.p.	prostatic pore
dig.gl.	digestive gland	pr.	prostomium
div.	spermathecal diverticulum	pv.	proventriculus
		s.	septum
e.d.	elimination duct	sac.	sac containing penial chaetae
f.p.	female pore		
g.	gizzard	sal.gl.	salivary gland
h.	heart	sem.gr.	seminal groove
int.	intestine	s.i.v.	supra-intestinal vessel
m.	mouth	sp.	spermatheca
m.f.	muscle fibre	sp.d.	spermathecal duct
mn.	micronephridial tubule	sp.p.	spermathecal pore
m.p.	male pore	t.	testis
n.	nephridium	t.f.	testicular funnel
np.	nephridiopore	t.pub.	tuberculum pubertatis
n.t.	nephridial tubule	v.d.	vas deferens
n.v.	nephridial vesicle	v.n.c.	ventral nerve cord
o.	ovary	v.s.	vesicula seminalis
oe.	oesophagus		

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Part Two

SYSTEMATICS

SYSTEMATIC LIST OF THE NEW ZEALAND EARTHWORM FAUNA

(Species marked (*) are regarded as introduced)

Family **MEGASCOLECIDAE**

Subfamily ACANTHODRILINAE

Tribe ACANTHODRILACEA

1. Genus ACANTHODRILUS Perrier emend. Pickford
   1. *A. kermadecensis* Lee

2. Genus DECACHAETUS n.g.
   1. *D. minor* n.sp.
   2. *D violaceus* n.sp.

3. Genus DEINODRILUS Beddard
   1. *D. agilis* Lee
   2. *D. benhami* Beddard
   3. *D. gracilis* Ude
   4. *D. kanieriensis* (Benham)
   5. *D. lateralis* n.sp.
   6. *D. montanus* Lee
   7. *D. parvus* Lee
   8. *D. suteri* Benham

4. Genus DINODRILOIDES Benham
   1. *D. beddardi* Benham

5. Genus EODRILUS Michaelsen emend. Pickford
   1. *E. annectens* (Beddard)
   2. *E. fallax* (Benham)
   3. *E. haplocystis* (Benham)
   4. *E. micros* n.sp.
   5. *E. montanus* n.sp.
   6. *E. pallidus* n.sp.
   7. *E. paludosus* (Beddard)
   8. *E. parvus* n.sp.
   9. *E. rossi* n.sp.

6. Genus EUDINODRILOIDES n.g.
   1. *E. forsteri* n.sp.

7. Genus HOPLOCHAETINA Michaelsen
   1. *H. durvilleana* (Benham)
   2. *H. pallida* Lee
   3. *H. polycystis* Lee
   4. *H. robusta* Lee
   5. *H. rossii* (Benham)
   6. *H. rubra* n.sp.
   7. *H. spirilla* n.sp.
   8. *H. subtilis* n.sp.

8. Genus LEUCODRILUS Lee
   1. *L. digitocystis* Lee
   2. *L. fuscus* Lee
   3. *L. robustus* n.sp.

9. Genus MICROSCOLEX Rosa emend. Pickford
   1. *M. aucklandicus* (Benham)
      M. aucklandicus var. *bollonsi* (Benham)
      M. aucklandicus var. *pallidus* (Benham)
   2. *M. campbellianus* (Benham)
   3. **M. dubius* (Fletcher)
   4. *M. macquariensis* (Beddard)
   5. **M. phosphoreus* (Dugès)

10. Genus *Octochaetus* Beddard
    1. *O. antarcticus* (Beddard)
    2. *O. brucei* Lee
    3. *O. huttoni* Beddard
    4. *O. kapitiensis* n.sp.
    5. *O. michaelseni* Benham
    6. *O. multiporus* Beddard
    7. *O. pelorus* n.sp.
    8. *O. ravus* n.sp.
    9. *O. sylvestris* Lee
    10. *O. thomasi* Beddard
    11. *O. tricystis* Lee

11. Genus PERIEODRILUS Michaelsen
    1. *P. lateralis* (Benham)
    2. *P. montanus* Benham
    3. *P. plunketi* (Benham)
    4. *P. ricardi* Benham

12. Genus RHODODRILUS Beddard
    1. *R. aduncocystis* Lee
    2. *R. agathis* n.sp.
    3. *R. albidus* Lee
    4. *R. aquaticus* n.sp.
    5. *R. attenuatus* Lee
    6. *R. benhami* Lee
    7. *R. besti* Benham
    8. *R. cockaynei* Benham
    9. *R. disparatus* Lee
    10. *R. dobsoni* n.sp.
    11. *R. edulis* Benham
    12. *R. huttoni* (Benham)
    13. *R. insularis* n.sp.

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14. *R. intermedius* Lee
15. *R. kermadecensis* Benham
16. *R. leptomerus* Benham
17. *R. macroseptus* Lee
18. *R. microgaster* n.sp.
19. *R. minimus* Lee
20. *R. minutus* Beddard
21. *R. papaensis* Lee
22. *R. parvus* Benham
23. *R. ravus* n.sp.
24. *R. robustus* Lee
25. *R. rosae* n.sp.
26. *R. similis* Benham
27. *R. subtilis* n.sp.
28. *R. sutherlandi* Lee
29. *R. tetratheca* n.sp.

13. Genus SYLVODRILUS n.g.
1. *S. gravus* n.sp.

Tribe NEODRILACEA

1. Genus MAORIDRILUS Michaelsen
1. *M. alpinus* n.sp.
2. *M. carnosus* n.sp.
3. *M. dissimilis* (Beddard)
4. *M. fuscus* n.sp.
5. *M. gravus* n.sp.
6. *M. megacystis* Benham
7. *M. michaelseni* Ude
8. *M. minor* n.sp.
9. *M. modestus* Michaelsen
10. *M. montanus* n.sp.
11. *M. nelsoni* n.sp.
12. *M. pallidus* n.sp.
13. *M. parkeri* (Beddard)
14. *M. plumbeus* (Beddard)
15. *M. purus* Ude
16. *M. ruber* n.sp.
17. *M. rubicundus* n.sp.
18. *M. smithi* (Beddard)
19. *M. suteri* Michaelsen
20. *M. tetragonurus* Michaelsen
21. *M. transalpinus* n.sp.
22. *M. uliginosus* (Hutton)
23. *M. ultimus* n.sp.
24. *M. volutus* n.sp.
25. *M. wilkini* n.sp.

2. Genus NEOCHAETA n.g.
1. *N. forsteri* n.sp.
2. *N. salmoni* n.sp.

3. Genus NEODRILUS Beddard
1. *N. agilis* Lee
2. *N. campestris* (Hutton)
3. *N. dissimilis* n.sp.
4. *N. edwardsi* n.sp.
5. *N. polycystis* n.sp.

4. Genus PLAGIOCHAETA Benham
1. *P. lineata* (Hutton)
2. *P. stewartensis* Michaelsen
3. *P. sylvestris* (Hutton)

INCERTAE SEDIS

1. *Octochaetus levis* (Hutton)
2. *Octochaetus microchaetus* (Benham)
3. *Rhododrilus monticola* (Beddard)
4. *Maoridrilus intermedius* Michaelsen
5. *Maoridrilus mauiensis* Benham
6. *Maoridrilus thomsoni* Benham

Subfamily MEGASCOLECINAE

1. Genus DIDYMOGASTER Fletcher
1. **D. sylvatica* Fletcher

2. Genus DIPOROCHAETA Beddard
1. *D. aquatica* Benham
2. *D. brachysoma* Benham
3. *D. caswelli* n.sp.
4. *D. chathamensis* Benham
5. *D. duodecimalis* (Michaelsen)
6. *D. heterochaeta* Benham
7. *D. intermedia* Beddard
8. *D. minima* n.sp.
9. *D. obtusa* Lee
10. *D. punctata* n.sp.

3. Genus MEGASCOLEX Templeton
1. *M. animae* n.sp.
2. *M. laingii* Benham
3. *M. novae-zealandiae* Lee

4. Genus Megascolides McCoy
1. *M. albus* Lee
2. *M. equestris* (Benham)
3. *M. esculentus* (Benham)
4. *M. fuscus* Lee
5. *M. huttoni* (Benham)
6. *M. irregularis* Lee
7. *M. kirki* (Benham)
8. *M. maoricus* (Benham)
9. *M. mortenseni* (Michaelsen)
10. *M. napierensis* Benham
11. *M. neglectus* Cognetti de Martiis
12. *M. parvus* Lee
13. *M. raglani* Lee
14. *M. reptans* (Ude)
15. *M. ruber* Lee
16. *M. rubicundus* n.sp.
17. *M. sapidus* (Benham)
18. *M. suteri* (Benham)
19. *M. tasmani* n.sp.
20. *M. unipapillatus* (Ude)
21. *M. urewerae* (Benham)
22. *M. viridis* Lee

5. Genus NOTOSCOLEX Fletcher
1. **N. hakeaphilus* Benham

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Systematic List of the New Zealand Earthworm Fauna—*continued*

6. Genus PERIONYX Perrier
   1. *P. egmonti* Lee
   2. *P. helophilus* (Benham)
   3. *P. perionychopsis* (Benham)
   4. *P. shoeanus* Cognetti de Martiis

7. Genus PHERETIMA Kinberg
   1. **P. peregrina* (Fletcher)

8. Genus PLUTELLUS Perrier
   1. P. *aucklandicus* Benham
   2. *P. parvus* n.sp.
   3. *P. stewartensis* n.sp.

9. Genus PONTODRILUS Perrier
   1. *P. lacustris* (Benham)
   2. *P. matsushimensis* var. *chathamianus* Michaelsen

10. Genus SPENCERIELLA Michaelsen
   1. *S. argillae* n.sp.
   2. *S. gigantea* (Benham)
   3. *S. pallida* n.sp.
   4. *S. shakespeari* (Benham)

INCERTAE SEDIS
   1. *Megascolex antarcticus* Baird
   2. *Megascolides orthostichon* (Schmarda)

Family **LUMBRICIDAE**
1. Genus *ALLOLOBOPHORA Eisen emend. Rosa
   1. **A. caliginosa* (Savigny) forma *typica* forma *trapezoides* Dugès
   2. **A. chlorotica* (Savigny)
   3. **A. terrestris* (Savigny) forma *longa* (Ude)
2. Genus *BIMASTUS Moore
   1. **B. eiseni* (Levinsen)
   2. **B. tenuis* (Eisen)
3. Genus *DENDROBAENA Eisen emend. Rosa
   1. **D. rubida* (Savigny)
   2. **D. subrubicunda* (Eisen)
4. Genus *EISENIA Malm emend. Michaelsen
   1. **E. foetida* (Savigny)
   2. **E. rosea* (Savigny) forma *typica*
5. Genus *EISENIELLA Michaelsen
   1. **E. tetraedra* (Savigny) forma *typica*
6. Genus *LUMBRICUS L.
   1. **L. castaneus* (Savigny)
   2. **L. rubellus* Hoffmeister
   3. **L. terrestris* L.
7. Genus *OCTOLASIUM Örley
   1. **O. cyaneum* (Savigny)

The word "earthworm" cannot be satisfactorily defined scientifically, but it is a useful term for a large number of species of the order Oligochaeta which inhabit soils and accumulations of decaying plant material, and are occasionally found in aquatic or littoral habitats. It corresponds more or less to the now outdated term Megadrili, which included the families Moniligastridae, Megascolecidae, Eudrilidae, Glossoscolecidae and Lumbricidae of the order Oligochaeta.

ORDER OLIGOCHAETA

The following diagnosis is taken from Stephenson (1930, p. 1). "Worms with internal segmentation and a usually corresponding external annulation; possessing chaetae, usually segmentally arranged throughout the greater part of the body, but not situated on parapodia; hermaphrodite, the male and female gonads being few in number (one or two pairs), situated in the anterior part of the body, the male anterior to the female; the genital products discharged by special ducts; a clitellum present at sexual maturity; the eggs deposited in a cocoon; without a free larval stage in development."

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The order Oligochaeta is grouped with the order Polychaeta to form the class Chaetopoda of the phylum Annelida.

THE CLASSIFICATION OF OLIGOCHAETA

Modern classification of the Oligochaeta dates from the publication of Volume 10 of Das Tierreich (Michaelsen, 1900). Various attempts had been made before 1900 to classify the Oligochaeta, notably those of D'Udekem (1862), Vaillant (1868), Perrier (1872), Vejdovsky (1884), Benham (1890a), Beddard (1895a), Michaelsen (1896, 1899a), but the publication of the Tierreich volume laid the basis of a classification which is still in use. In the Tierreich Michaelsen gave definitions of each of the known species and genera, classified into subfamilies and families, with a list of the localities from which they had been recorded. Michaelsen recognised 11 families, including about 1200 species of about 152 genera.

For many years after the publication of Michaelsen's classification, Michaelsen, Stephenson, and Benham published at length on earthworms and their classification. This was a period during which the earthworm fauna of much of the world was being studied for the first time in detail. Over the years, mainly owing to the influence of Michaelsen, the classification of groups smaller than families became dominated by the concept of "family trees" of generic relationships. It was assumed that the genera could be arranged in a phylogenetic series and that most, if not all, of the evolutionary changes which gave rise to any particular extant genus were to be found represented in other extant genera further down the "family tree". As new genera were described they were fitted into the "family tree". In order to do this it was necessary to restrict the definitions of genera to a description of a few, carefully selected anatomical features. The degree of significance attached to individual characters varied from genus to genus to suit the requirements of the "family tree". The result was a scheme of classification which, although it had a superficial appearance of almost mathematical precision, became cumbersome and ambiguous in detail.

Michaelsen (1921) put forward a classification in which he recognised 21 families, grouped in 2 suborders. It consisted essentially of a rearrangement of his former classification, raising some subfamilies to families. The families were grouped in series.

Michaelsen (1929) proposed a further subdivision, in which 3 suborders were recognised, each including several series of families.

Stephenson (1930) recognised 14 families little different from those of Michaelsen (1900). Stephenson's definitions of families are recognised in the present work.

This volume is concerned with the earthworm fauna of the New Zealand region. Two groups of earthworms are included, a large group of species, nearly all endemic, of the family Megascolecidae, and a small group of introduced species belonging to the family Lumbricidae. The family Megascolecidae is the largest family of Oligochaeta, including more than half the known species. It is widely distributed and has been most widely discussed by previous workers.

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Family MEGASCOLECIDAE

1900. Fam. *Megascolecidae* (part, excluding Eudrilinae), Michaelsen, Tierreich 10:161.
1923. Fam. *Megascolecidae* (part, excluding Eudrilinae), Stephenson, Fauna Brit. India, Olig. p. 162.
1928. Superfam. *Megascolecina* (part, excluding Eudrilidae), Michaelsen, Handbuch der Zool. 2 (8) :108.
1930. Fam. *Megascolecidae,* Stephenson, Oligochaeta p. 818.
1937. Fam. *Megascolecidae,* Pickford, Monograph p. 98.

The following is taken, almost unchanged, from Stephenson (1930, p. 818).

"Chaetae sigmoid, simply pointed, eight, ten, twelve or more than twelve on each segment. Clitellum beginning with or in front of xv. One pair of male pores, usually on xvii or xviii, seldom on xix. Female pores paired, or a single median pore, with few exceptions on xiv. An

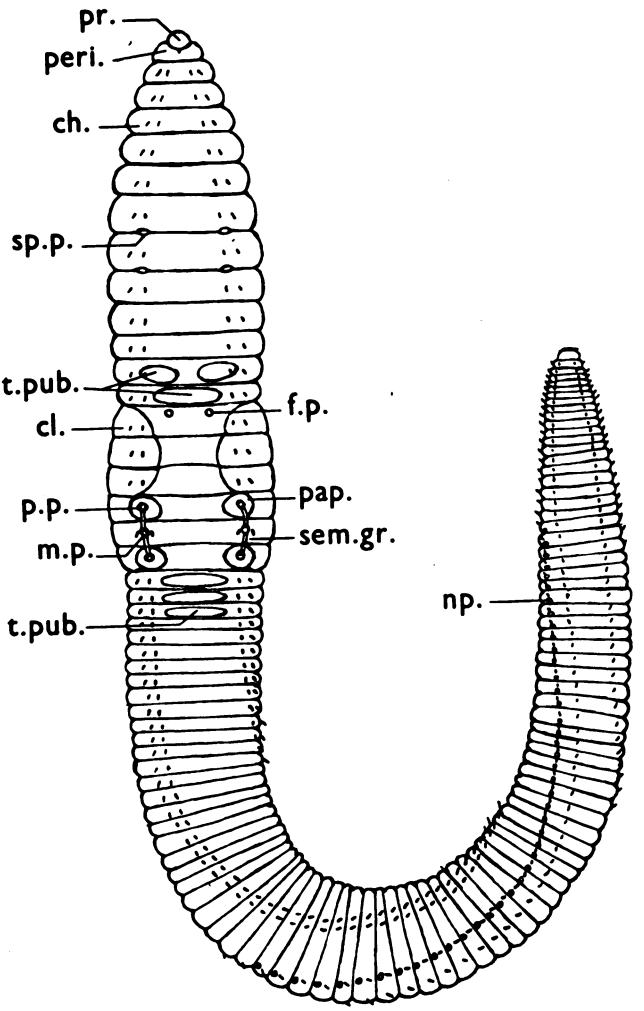

FIG. 1. External features of a "typical" megascolecid

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oesophageal gizzard usually present. Two pairs of testes in segments x and xi, or one pair only, in x or xi. One or two pairs of prostates; prostates rarely absent. One pair of ovaries in xiii."

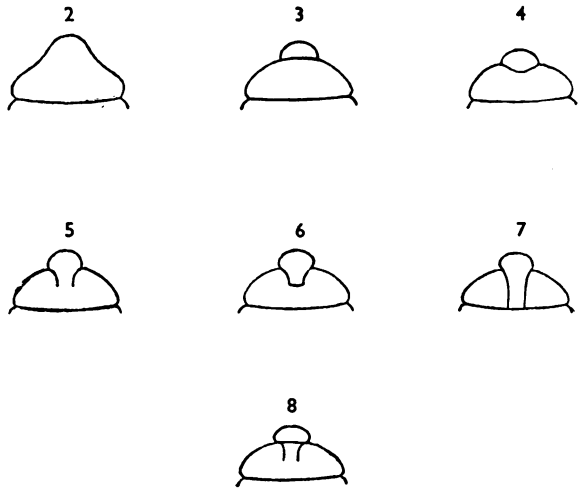
GENERAL MORPHOLOGY

EXTERNAL FEATURES (Fig. 1)

Size: The size of megascolecid earthworms is extremely variable. The largest known species is *Megascolides australis,* an Australian species, which is said to be up to 3 m. long. The largest New Zealand species is *Spenceriella gigantea,* 1300–1400 mm. long and about 11 mm. in diameter, while a number of the smallest species are 15–25 mm. long and 1–2 mm. in diameter, for sexually mature specimens. The size and number of segments of sexually mature individuals of a species may vary considerably.

Colour: Most megascolecids are red or brown. The red colour is sometimes entirely due to the colour of the haemoglobin of the blood showing through the epidermis, but red, purple or brown pigments are frequently present, especially on the dorsal surface. The ventral surface is usually unpigmented or very lightly pigmented. Some megascolecids, especially those which inhabit forest leaf mould, are deeply pigmented, sometimes with striking patterns of contrasting colours, and these species are usually pigmented both dorsally and ventrally.

Prostomium: The prostomium is a mid-dorsal lobe, projecting forward from segment i above the mouth. The prostomium may be prolonged back over segment i, or separated from i by a transverse groove,



FIGS. 2–8. Various types of prostomium.
2. zygolobous
3. prolobous
4. proepilobous
5 and 6. epilobous
7. tanylobous
8. combined pro- and epilobous.

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or continuous with i. The various types of prostomium are illustrated in Figs. 2–8.

Segmentation: The segments are divided externally by intersegmental furrows which correspond to internal septa. In this work individual segments are numbered in Roman numerals, commencing from the anterior end; intersegmental furrows are numbered consecutively, using Arabic numerals, e.g., 7/8 denotes the furrow between vii and viii; intersegmental septa are numbered consecutively in Roman numerals, e.g., vii/viii.

Chaetae: Chaetae commence on ii and occur on each segment posteriorly. They are generally sigmoid in form and there may be eight, ten, twelve or more than twelve on each segment, usually symmetrically disposed each side of the dorso-ventral axis. They are frequently arranged in pairs on each side. The term lumbricine is sometimes used to denote eight chaetae on each segment and the term perichaetine for more than twelve on each segment. The chaetae are designated in order from the most ventral on each side of each segment to the most dorsal, by the letters a, b, c, d, e, etc. The intervals between the chaetae are denoted by ab, bc, cd, etc. The positions of genital pores, nephridiopores, etc. on segments are designated by their relationship to the position of the chaetae. Where the chaetae are symmetrically disposed it is convenient to imagine a number of longitudinal lines drawn through consecutive chaetae a, b, c, d, etc., and refer the positions of the pores to these lines. Some chaetae in the vicinity of the male pores may be modified in size and form and are then named penial chaetae.

Clitellum: The clitellum is a thickened glandular portion of the epidermis developed over a number of segments in the region of the male and female pores in sexually mature worms. It may be "complete", i.e. developed over the entire surface of the segments, or it may be developed only dorsally and laterally.

Genital Pores: Earthworms are hermaphroditic. All the genital pores in Megascolecidae are ventral or ventro-lateral; they are usually paired, but are sometimes unpaired and mid-ventral. The *male pores* are the external openings of the vasa deferentia. They are always close to, and sometimes open in common with the *prostatic pores.* The prostatic pores usually open on the apices of papillae. There are one or two pairs of prostatic pores, on xvii or xix or xvii and xix (Acanthodrilinae) or xviii (Megascolecinae). The fusion of male and prostatic pores is generally confined to species with only one pair of prostates and the combined pores are usually on xvii (Acanthodrilinae) or xviii (Megascolecinae), but the male pores are occasionally fused with one or other of the pairs of prostatic pores in a species with two pairs of prostatic pores. In the Acanthodrilinae, where the male pores are not fused with the prostatic pores, a longitudinal seminal groove on each side usually connects the male pore to the prostatic pore or pores. The *female pores* are usually on xiv; occasionally there is a single median ventral female pore. *Spermathecal pores* are usually intersegmental but occasionally on the segments, anterior to 9/10. Occasionally the pores are median ventral and unpaired.

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Tubercula pubertatis: Tubercula pubertatis are glandular cushion-like thickenings on the ventral or ventro-lateral aspects of some anterior segments, associated with the genital pores. They may be unpaired and symmetrically disposed across the ventral midline, or paired ventro-lateral structures. They are not present in all Megascolecidae, and when they are present their position is subject to individual variation.

Nephridiopores: In meganephridial species a pair of nephridiopores is present on each segment except i. They are close to the intersegmental furrows at the anterior margins of segments and their position is always designated in relation to the lines of chaetae.

INTERNAL ANATOMY (Figs. 9, 10)

Septa: Intersegmental septa are occasionally absent in a few anterior segments. In some species a number of the anterior septa are thickened and extremely muscular.

Alimentary Canal: The *mouth* opens into a large *pharynx,* usually occupying i–iv, which is eversible. In feeding, the pharynx is everted, the food is seized, and strong extrinsic muscles, which are inserted into the body wall, retract the pharynx. The pharnyx usually opens into a strong muscular *gizzard,* which is in the region of v–x, often via a short, wide, non-muscular *proventriculus,* in v. The gizzard is occasionally small or entirely absent. The *oesophagus* extends from the gizzard back to the intestine, which usually commences about xv–xx. Oesophageal or calciferous glands frequently open into the oesophagus. These are paired glands, lateral or ventro-lateral, or occasionally unpaired and ventral; they may be distinctly separated from the oesophagus, or, more usually, swellings of the oesophageal wall. The *intestine* is wide and thin walled. Frequently it is a simple tubular organ, but it may have a typhlosole, which is a deep in-folding, usually dorsal in position, or occasionally the intestine is a narrow, thin-walled tube, spirally coiled. The intestine extends back to the anus.

Vascular System: The most obvious blood vessels are the dorsal vessel (paired or unpaired), which lies along the mid-dorsal aspect of the alimentary canal, giving off lateral vessels segmentally; a supra-oesophageal vessel (unpaired), which lies beneath the dorsal vessel or vessels; two to five pairs of hearts, which are segmental, contractile, commissural vessels, the last pair in xi, xii or xiii, rising from the dorsal vessel, the supra-oesophageal vessel, or receiving a branch from each of those vessels, and terminating in the ventral (or supra-neural) vessel.

Nervous System: The brain, or cerebral ganglion, is situated dorsally, close to the anterior end of the pharynx. From it arise a pair of lateral commissures which encircle the pharynx, fusing in the mid-ventral line with the ventral nerve cord, which runs back along the mid-ventral line to the posterior end of the body and has a ganglion in each segment from which arise, laterally, the segmental nerves.

Reproductive System: Male and female organs are present, but earthworms are not self-fertile and copulatory structures are developed.

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There are two pairs of *testes,* a pair in x and a pair in xi, or one pair in x or xi. The testes are usually attached to the anterior septum of the segment, ventro-laterally, one on each side, and usually project freely into the coelom, but sometimes (e.g., in *Acanthodrilus*) they are enclosed in testis sacs. Corresponding to each testis and projecting forwards in the testicular segment is a testis funnel. The funnels are the anterior openings of the vasa deferentia, which run longitudinally back through the body, often within the body wall, to xvii or xviii, where they open to the exterior at the male pores. Where there are fused male and prostatic pores, the vasa deferentia usually fuse with the prostatic ducts in the coelom or in the body wall. Associated with the testes are one to four pairs of *vesiculae seminales.* These are attached to the intersegmental septa and serve as reservoirs for sperm mother cells, produced by the testes, which develop further within the vesiculae to produce the sperm cells. The *prostates* are associated with the posterior ends of the vasa deferentia. They are large glands which produce a liquid medium for the transfer of sperm cells from one worm to another. Prostates in Megascolecidae are of two types: tubular, in which the prostatic duct is continuous with a central unbranched canal running through a long tubular prostatic gland; or racemose, in which the glandular tissue is of a more compact form, with a system of branching canals opening into the prostatic duct. Accessory copulatory structures of two main types are frequently associated with the prostates.

Penial chaetae are specialised chaetae, contained in a sac which opens to the exterior beside the prostatic duct; they are usually much longer than normal chaetae (sometimes the sac containing the penial chaetae extends through several segments), are ornamented with spines, ridges or pits, and have their points modified in unusual shapes. The sac containing the penial chaetae is attached to the body wall by a strong retractor muscle.

Copulatory muscles are strong fibres arising from the ventro-lateral region of the body wall, close to the prostatic ducts, and inserted into the body wall dorso-laterally.

Paired *spermathecae* occur in one or more consecutive segments anterior to ix/x. A typical spermatheca consists of a large sac with a duct, which passes forward to open ventro-laterally in an intersegmental position or close to the anterior margin of the segment, at the spermathecal pore. Usually one or more diverticula rise from the spermathecal duct and may lie beside or below the sac within the spermathecal segment or may project through the septum into the adjacent anterior segment.

The *ovaries* are in xiii, in a similar position to the testes. Ovarian funnels, similar to the testicular funnels, correspond to the ovaries. The ovarian funnels are the anterior openings of the oviducts, which pass back from xiii to xiv, where they open to the exterior.

In copulation, the prostatic pores, or combined male and prostatic pores, are placed opposite the spermathecal pores of another worm; penial chaetae, if present, are inserted into the spermathecal pores, or

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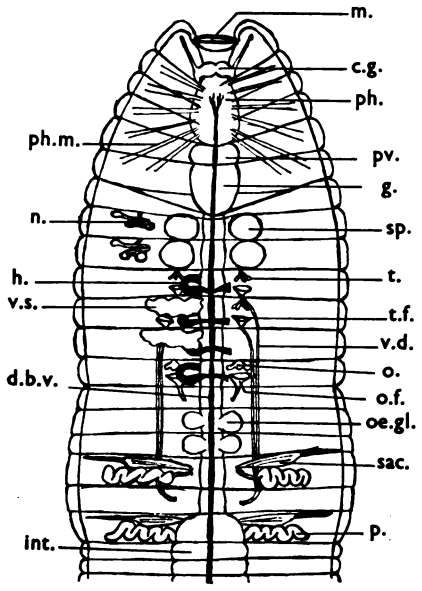

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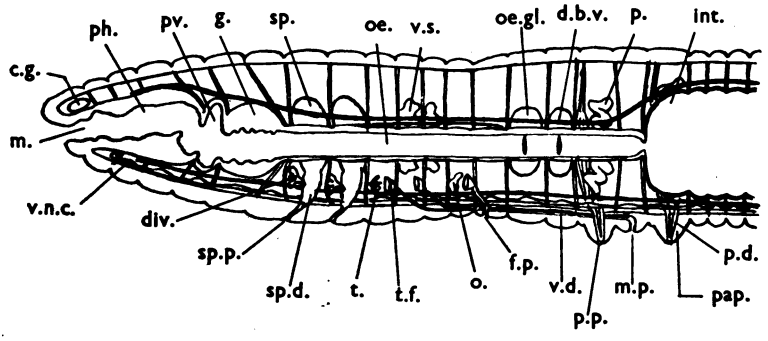

FIG. 9. Dissection of "typical" megascolecid from dorsal aspect, segments i–xxi
FIG. 10. Diagram of "typical" megascolecid, bisected longitudinally along dorso-ventral axis

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by contraction of the copulatory muscles the other worm is gripped firmly; sperm cells are liberated from the male pores into the seminal grooves, and transferred, in prostatic fluid, into the spermathecal ducts of the other worm. The sperm cells are stored in the spermathecal diverticula and a nutrient fluid is secreted by gland cells in the spermathecal sacs. In oviposition the clitellum secretes a gelatinous sleeve-like structure which is worked forward over the body, receiving ova as it passes the female pores, and sperm cells as it passes the spermathecal pores. As the "sleeve" passes off the anterior end of the body, its ends are sealed and it becomes a cocoon.

Nephridia: Two main types of nephridia, meganephridia and micronephridia, are recognised in Megascolecidae. Many varieties of each type are recognisable and have been given names. Meganephridia are long, coiled, tubular structures, usually one pair in each segment. They arise from a small funnel, which projects through the septum into the adjacent anterior segment, and discharge at the nephridiopores. Micronephridia are small tubular structures, usually very numerous in each segment. They have no funnels nor nephridiopores, but discharge waste products into the coelomic fluid whence they are excreted through dorsal pores. In some genera and species meganephridia and micronephridia occur together, but more frequently genera and species are either meganephridial or micronephridial.

TAXONOMIC CHARACTERS

The differences between megascolecid species are frequently small and in a taxonomic description of a species it is necessary to describe all the morphological characters described in the previous section.

GENERIC CHARACTERS

The characters used in distinguishing genera are as follows:

Chaetae: Genera are frequently distinguished by the number of chaetae on each segment, the most common distinction being between the lumbricine and the perichaetine arrangements. The chaetal arrangement is invariable at the generic level and is a reliable generic character.

Male Genital Pores: The number of pairs of prostatic pores is frequently used in distinguishing genera, e.g., *Maoridrilus* and *Neodrilus*, or *Acanthodrilus* and *Rhododrilus* may be distinguished by their possession of two pairs or one pair of prostatic pores. The position of the prostatic pores is also used to distinguish some genera.

Nephridiopores: In some genera (Neodrilacea) there is a more or less regular alternation of the nephridiopores between dorso-lateral and ventro-lateral positions in successive segments. This contrasts with other meganephridial genera, in which the pores are in a single series on each side.

Gizzard: Some genera are distinguished by the presence or absence of a gizzard. This is not a good generic character, since in most cases there are intermediate species in which the gizzard is so small that it is difficult to distinguish.

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Prostates: The form of the prostates, whether tubular or racemose, is frequently used. This character can also be confusing since intermediate forms of prostate are known, but it can be used in many cases.

Nephridia: Many genera are distinguished according to whether they are mega- or micronephridial.

Nephridial Vesicles: The presence or absence of terminal vesicles on meganephridia, and their form, can be useful generic characters. Pickford (1937) achieved a clear distinction of *Eodrilus, Microscolex,* and *Acanthodrilus* based on nephridial vesicles.

SPECIFIC CHARACTERS

The characters that have been found most useful in distinguishing species are as follows:

Size: Some indication of size is useful, but cannot be relied upon too closely.

Pigmentation: This is also useful, but it is essential that the colour of living specimens should be described, as fixatives and preservatives dissolve many pigments.

Genital Pores: The number and position of the spermathecal pores, prostatic and male pores are reliable specific characters.

Septa: The number and position of any thickened and muscular septa are constant features of specific importance.

Alimentary Canal: The position of the gizzard, limits of the oesophagus and intestine, and number and position of oesophageal glands are frequently useful specific characters.

Vascular System: The dorsal blood vessel may be paired or unpaired and its condition is constant for a species. The number and position of the hearts and their origin from the dorsal or supra-oesophageal vessels are also constant in a species.

Penial Chaetae: Provided the penial chaetae are not broken their form is one of the most useful of specific characters.

Spermathecae: The number and form of the spermathecae are generally invariable, readily recognisable specific characters.

Male Organs: There may be one or two pairs of testes. Usually there are two pairs but when only one pair is present this is a useful specific character.

Nephridial Vesicles: In some meganephridial genera, vesicles may be present in some species and absent in others, and when present may take various forms. In such cases the vesicles are useful and reliable specific characters.

CLASSIFICATION

Michaelsen (1900) recognised 633 species of Megascolecidae and he divided them among 57 genera and 7 subfamilies. (The number of subfamilies was subsequently reduced to 5). Of these, 3 subfamilies, Acanthodrilinae, Megascolecinae and Octochaetinae were represented

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in the New Zealand region. He considered that all the genera in the family have been derived from a primordial form which had the following characters: eight chaetae on each segment; two pairs of prostatic glands, opening to the exterior on xvii and xix; two pairs of testes, a pair in x and a pair in xi, with the vasa deferentia opening to the exterior on xviii; two pairs of spermathecae, a pair in viii and a pair in ix; a well developed gizzard; a meganephridial excretory system. This ancestral genus has been variously named "the acanthodriline primordial form", "acanthodriline ur-form" and the "*Notiodrilus* ancestral form". The characters designated for the ancestral genus are identical with those of the extant genus *Eodrilus* and this name has sometimes been applied to the ancestral genus.

Michaelsen (1907a, 1909a) worked on the Megascolecid faunas of south-western Australia and the Indian region and, in a paper on the latter, gave a comprehensive account of his views on the relationships of genera within the Megascolecidae. Beginning from the "acanthodriline primordial form" and taking this as the ancestor of all the Megascolecidae, he came to the following conclusions concerning the Megascolecidae of India and other regions of the world:

1. The Megascolecinae are derived from *Eodrilus* through the "intermediate genus" *Diplotrema* from Australia, which must therefore be regarded as the headquarters of the phyletically older genera of this subfamily. Genera have spread out "centrifugally" from Australia.
2. The phyletically oldest genera, *Plutellus, Megascolides* (and *Diporochaeta*), *Spenceriella,* and *Woodwardia,* with Australia as headquarters, have spread all over India, New Zealand (all but *Woodwardia*) and to North America (*Megascolides* only).
3. The phyletically intermediate genera, *Notoscolex* and *Megascolex,* are found in Ceylon, India and Australia, New Caledonia and Norfolk Island. This fact would indicate that they have spread, but not as far as the phyletically older genera. Why *Diplotrema* remains confined to Australia when it is the basic and therefore the oldest genus is not explained.
4. The "side branch" consisting of *Perionychella, Perionyx* and *Lampito* is represented by *Perionychella* in Australia; otherwise, it is confined to India.
5. The phyletically youngest genus *Pheretima* is found in Burma and the Andaman Islands, advancing from its Malayan headquarters.

Concerning the subfamily Octochaetinae, Michaelsen states that:

1. The Octochaetinae represent a relation of the Indian region to New Zealand alone, not touching Australia. (Since *Octochaetus* is recorded only from India and New Zealand).
2. *Octochaetus* has been derived from the "primordial acanthodriline", possibly through the "intermediate genus" *Howascolex,* from Madagascar.
3. The genus *Eudichogaster* is found only in north-west India and may have been derived from *Octochaetus* by duplication of the

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gizzard. *Octochaetus* is absent from the "dominion" of *Eudichogaster*. "It almost seems as though the conjectured octochaetine ancestor completely changed to *Eudichogaster* whilst entering and occupying this north-western district." *Eudichogaster,* further, might be regarded as the ancestor of *Dichogaster,* which then must have spread out from India to east Africa, thence across Africa and finally to the West Indies and central America.

4. In New Zealand, *Deinodrilus* was locally derived from *Octochaetus*.

5. *Hoplochaetella* (which included the New Zealand genus *Hoplochaetina*) occurs in India and New Zealand, like *Octochaetus*.

Having made these assertions, Michaelsen interpreted the geographical distribution of Megascolecidae in terms of his supposed phylogenetic relationships. The distribution of the Megascolecinae requires the existence of an archipelago between India and Australia, of which India was a part, the outlines of this archipelago changing from time to time so that at times some islands may be continuous and at other times discontinuous; this would have allowed worms to move in one direction at one time, and in another direction at another time. At times northern and southern India would have been isolated from one another but joined to islands to the south-east, while at other times northern and southern India would have been joined. It is implied, though not actually stated, that at some time Australia was joined to North America to allow *Megascolides* to achieve its distribution. Australia would at some time have been joined to New Zealand and New Zealand to Chatham Is.

The distribution of the Octochaetinae would require a land bridge to have existed between India and New Zealand without including any part of Australia. It would also require connections between Madagascar and India, between India and east Africa (separate from the Madagascar-India connection) thence across Africa and the Atlantic Ocean to the West Indies and Central America.

The absence of relics of migrating faunas in regions between discontinuous centres of present distribution is accounted for either by the elimination of such relics by more recent genera e.g., *Pheretima* in Malaya and Indonesia, or by the complete disappearance beneath the ocean of former land areas and their faunas.

To sum up, Michaelsen's assertions require a network of land connections radiating out "centrifugally" from Australia right around the world, to meet in the American continent, and including little of what is at present land. The land connections are not said to have existed contemporaneously, but they all must have been present at some time.

On this basis of conjectured relationships, based on a hypothetical "primordial form" and requiring a system of land connections encircling the earth to explain the geographical distribution of closely related forms, Michaelsen erected his classification of the Megascolecidae.

Stephenson (1921b) considered that Michaelsen's extensive land bridges were unnecessary to explain the distribution of Megascolecidae; rafting, chance transport by birds, the existence of euryhaline species and polyphyly would be sufficient to explain most, if not all, of the present distribution pattern. Stephenson considered that earthworms

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are a fairly recent group of animals and that the genera which are considered most important in land bridge theories (Megascolecinae) are probably the most recent of genera. Since the food of earthworms is vegetable mould there were presumably no earthworms in existence until vegetable mould was present in sufficient quantities to nourish them; this led Stephenson to the assumption that the rise of earthworms began at some time not earlier than the spread of dicotyledonous plants, which took place during the Cretaceous, and he considered that the evolution of the first earthworms and of many genera and families has taken place during the Tertiary and Recent. Most of the stages in the evolution of this "rapidly evolving" group are extant, and therefore Michaelsen's "family tree" of generic relationships could be accepted as a basis for the classification of Megascolecidae.

There is no reason why dicotyledonous plants should be a prerequisite for the existence of earthworms, which are found living in moss, and under ferns and conifers. Some are even aquatic or littoral. In New Zealand there have been two major invasions of earthworms; the first of Acanthodrilinae, and the second of Megascolecinae. The Acanthodrilinae must have been in New Zealand for much longer than the Megascolecinae, since the former group is composed almost entirely of endemic genera, while the latter group includes no endemic genera. The distribution pattern of Megascolecinae in New Zealand shows that they must have come from the direction of the Australian mainland and the composition of the New Zealand fauna indicates that there cannot have been a land connection between New Zealand and Australia during Tertiary times. If the Megascolecinae entered New Zealand earlier than Tertiary times and have not yet given rise to endemic genera it is reasonable to assume that the Acanthodrilinae entered New Zealand a long time previous to the Tertiary. The Acanthodrilinae cannot be regarded as the progenitors of all earthworms, and the origin of earthworms must therefore have been far back in geological time. Earthworms were probably among the first animals to colonise the land; they are probably a very slowly evolving group of animals, comparable perhaps to the Brachiopoda, and the presence of morphologically indistinguishable forms (such as the genus *Octochaetus*) in widely separated land masses could be due to the survival of very ancient forms through long periods of geological time.

Stephenson (1930) adhered closely to Michaelsen's classification. He pointed out that since Michaelsen's paper was published (1909) some genera have been found in regions intermediate between the centres of distribution delineated by Michaelsen. He did not consider it necessary to suppose that India was divided into islands, but agreed that a land connection has existed between India and Australia. To explain the more disjunct distribution of some of Michaelsen's other genera he asserted that some genera of Megascolecidae are polyphyletic, e.g., *Octochaetus* and *Megascolex*. His scheme of classification was identical, except in some minor details, with that of Michaelsen, although his opinions as to how the genera achieved their present distribution are more reasonable than those of Michaelsen.

Stephenson summarised the classification of Megascolecidae into subfamilies (1930, p. 819), as follows:

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"From the root (*Notiodrilus*) spring, not a single trunk, but several considerable stems, while round the base of these cluster a number of smaller shoots of less importance. Each of the larger stems with its branches constitutes a subfamily; while the smaller shoots are too insignificant to be individually so named and convenience is best served by grouping them together as a single subfamily. The larger stems are the Megascolecinae, the Octochaetinae, the Diplocardiinae and the Ocnerodrilinae; while the brushwood round the base, together with the common ancestor, constitutes the subfamily Acanthodrilinae.

"The Megascolecinae are derived from the *Notiodrilus* ancestor by the disappearance of the anterior prostates and approximation (*Diplotrema*) of the posterior prostatic duct and pore to the vas deferens and male pore, followed by fusion of prostatic and male pores (*Plutellus*) on segment xviii. (This is termed microscolecine reduction). A breaking up of the nephridia – the substitution of the micronephridial for the meganephridial condition of the ancestor – which is seen beginning in *Howascolex*, furnishes the point of departure of the Octochaetinae. The first step in the evolution of the Diplocardiinae is the duplication of the gizzard of the *Notiodrilus* ancestor (genus *Diplocardia*); while the Ocnerodriline stem owes its origin to the development of oesophageal pouches or calciferous glands in segments ix and x."

Stephenson's scheme of classification has many weaknesses. The micronephridial condition is taken as the diagnostic character of the Octochaetinae, yet in the Megascolecinae many genera are micronephridial, some are meganephridial, and some have meganephridia and micronephridia. In the Acanthodrilinae, one species (*Rhododrilus disparatus*) has micronephridia and meganephridia in some segments, and in the Octochaetinae the so-called "basal genus", *Howascolex*, has meganephridia and micronephridia. Stephenson's Diplocardiinae comprised a mixture of micronephridial and meganephridial genera, but Michaelsen (1933) transferred the micronephridial genera to the Octochaetinae, and Pickford (1937) transferred the meganephridial genera to the Acanthodrilinae, so the subfamily is no longer recognised. However, there does not seem to be any reason for the micronephridial condition in Stephenson's Octochaetinae being allocated more importance than the same condition in any other of Stephenson's subfamilies. Stephenson maintains that in the Octochaetinae the development of micronephridia was the first evolutionary step which distinguished all the Octochaetinae from the *Notiodrilus* ancestor, whereas in the other subfamilies the development of the micronephridial condition took place subsequent to the changes which gave rise to the subfamilies. Stephenson had no direct evidence of the order in which the changes took place in any of the subfamilies, and there is no reason to suppose that the order he selected is any better than a number of other orders that might have been selected.

The position of Stephenson's subfamily Ocnerodrilinae is by no means clear. Its distinguishing character is the presence of a ventral diverticulum or a pair of ventro-lateral or lateral (rarely dorsal) diverticula of the oesophagus, with the structure of calciferous glands, in ix or in the two segments ix and x. Apart from this character, the

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genera assigned to the Ocnerodrilinae would be divided among the Acanthodrilinae and the Megascolecinae. In the Acanthodrilinae and Megascolecinae there is a tendency for the calciferous glands to be placed more posteriorly than in the genera assigned to the Ocnerodrilinae, but it is by no means a universal characteristic. In the New Zealand Acanthodrilinae there is a strong tendency for the calciferous glands to be lacking, e.g., in *Neochaeta* calciferous glands are unknown, and in *Rhododrilus* only 10 of 29 known species possess calciferous glands. The complete absence of these glands must surely be a character of equal or even greater significance than the "forward displacement" of the glands by a few segments, yet the absence of calciferous glands in *Rhododrilus* is treated as a character of only specific importance. The Acanthodrilinae as defined by Stephenson included species which have calciferous glands in vii–ix, and it is difficult to justify his separation of species with the glands only in ix or ix and x as a distinct subfamily. Stephenson's explanation was again the order in which changes have taken place, but since there is no evidence that he chose the correct order the explanation is unacceptable.

The changes which gave rise to the subfamilies from the *Notiodrilus* ancestor were, according to Stephenson, irreversible. However, in at least one case a genus was said to have been derived by a change which was the reverse of the change supposed to have established the subfamily. *Monogaster*, an African genus, included by Stephenson in his subfamily Diplocardiinae, was said to have been derived from *Dichogaster* by the fusion of the two gizzards of the former genus. Morphologically, *Monogaster* is indistinguishable from *Octochaetus*, but Stephenson maintained that the order in which the morphological characters of the two genera had been evolved was not the same, and they occupied widely different positions on his "family tree" and in his classification.

The Indian species of *Octochaetus* were removed to a subgenus *Octochaetoides* Michaelsen by Michaelsen and Stephenson, to distinguish them from the New Zealand species which were placed in a subgenus *Octochaetus*. If the two subgenera are closely related, as is claimed by Michaelsen and Stephenson, *Octochaetus* must have been established in New Zealand since before Tertiary times, and must have remained unchanged ever since. Michaelsen (1909a) stated that in north-west India *Octochaetoides* appears to have changed completely into *Eudichogaster* while entering and occupying this region. On the one hand evolution seems to have been retarded while on the other hand it seems to have been accelerated. Similar cases of retarded and accelerated evolution are found in other genera.

Since 1930 no new classification of the Megascolecidae has been published but some parts of Stephenson's classification have been critically examined by Gates and Pickford.

Gates (1937, 1938, 1939, 1940) in a series of papers on Indian and Burman Megascolecinae and Octochaetinae disagreed with Stephenson's (and Michaelsen's) method of defining genera. He did not attempt to revise the whole system of classification, but worked very carefully through large numbers of specimens, describing each species and

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genus in great detail, in the hope that eventually a new classification might be possible. He drew very fine distinctions between genera and established a number of new genera.

Pickford (1937) found Stephenson's classification of Acanthodrilinae unsatisfactory in some minor respects. She achieved considerable success in clarifying the status of some acanthodriline genera on the basis of the form of their nephridial vesicles, and considered that the nephridial vesicles might eventually be more widely used as a basis for the classification of the Acanthodrilinae.

To sum up, the classification of Megascolecidae, originally (up to 1900) based on morphological similarities, has been modified, principally by Michaelsen and Stephenson, in an attempt to make it conform to a hypothetical phylogenetic series. This has been possible only by restricting the definitions of genera to a few carefully selected anatomical features, to any one or combination of more than one of which a special importance may be attached, depending on the position of the genus in a hypothetical "family tree". The phylogenetic series has, in fact, become more important than morphological and anatomical similarity and the position of a genus within the Megascolecidae can only be determined by its position in the family tree. The changes which are supposed to have given rise to any one genus, commencing from a hypothetical "primordial genus", have been arranged in an inflexible order which has no factual basis. Gates has rejected the concept of the "family tree", but has not re-classified the Megascolecidae as a whole.

The classification takes little account of possible natural relationships. New Zealand Megascolecidae are, in many cases, highly selective of their ecological conditions, and species sometimes exhibit a considerable degree of morphological and physiological specialisation, which may be correlated with their ecological preferences (examples are included in Part 4 of this work). As the classification is at present constituted, it is not necessary to make use of such characters in describing species, and it has not been the custom to take account of these characters. The result has been the development of a classification based on definitions rather than natural relationships. An example of the shortcomings of classification by definition may be seen in the case of *Pontodrilus lacustris* (Benham) (see p. 329), which by definition is included in *Pontodrilus,* but on the basis of its closest affinities should be included in the genus *Plutellus.* The geographical distribution of species within genera and genera within subfamilies should also be explicable in terms of the natural relationships of the species or genera concerned. This is a fact which has received little or no attention in the systematics of Megascolecidae except in the most general terms, on a world-wide basis. (An exception to this generalisation is to be found in the work of Pickford (1937)). I have attempted, with varying success, to relate the distribution of New Zealand species and genera to their supposed systematic relationships.

The artificial nature of the classification is particularly marked in the definitions of genera. In the present work, Stephenson's definitions of genera have been critically examined and, wherever possible, expanded and modified in an attempt to make them conform to

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a less artificial scheme of classification. Re-definition of genera has been relatively simple in the case of endemic genera, where most of the species have been examined, but in some non-endemic genera it has not been possible, since only a small proportion of the total number of species are found in the New Zealand region. There is a need for a re-examination of much of the world's Megascolecidae and a re-appraisal of the definitions of genera and the concepts on which these definitions are based. If this were done, it may be found that an entirely new basis of classification is necessary. In the meantime, while agreeing with Gates that the "family tree" is unacceptable, I consider that Stephenson's classification can be made more useful by grouping the genera on the basis of morphological similarities. Two subfamilies can be recognised within the New Zealand Megascolecidae. The two subfamilies are distinguished primarily on morphological grounds, but the geographical distribution of genera within the region and the degree of endemism within the subfamilies tend to confirm the significance of the subfamilies as taxonomic units.

The following are definitions of the two subfamilies, distinguished according to the positions of the male and prostatic pores.

Subfamily Acanthodrilinae:

One pair of prostatic pores on xvi (rarely) or xvii or xix, or two pairs on xvii and xix (rarely the two pairs may be further back); one pair of male pores, usually on xviii, sometimes on neighbouring segments, sometimes combined with a pair of prostatic pores (in which case, never on xviii); prostates with unbranched central canal.

Subfamily Megascolecinae:

Genera with one pair of prostatic pores and one pair of male pores on xviii (*Diplotrema* only) or one pair of combined male and prostatic pores on xviii; prostates with unbranched or branched central canal.

Seventeen New Zealand genera, *Acanthodrilus, Decachaetus, Deinodrilus, Dinodriloides, Eodrilus, Eudinodriloides, Hoplochaetina, Leucodrilus, Microscolex, Octochaetus, Perieodrilus, Rhododrilus, Sylvodrilus, Maoridrilus, Neochaeta, Neodrilus* and *Plagiochaeta* are included in the subfamily Acanthodrilinae, while ten genera, *Didymogaster, Diporochaeta, Megascolex, Megascolides, Notoscolex, Perionyx, Pheretima, Pontodrilus, Plutellus* and *Spenceriella* are included in the subfamily Megascolecinae.

Of the Acanthodrilinae, all but *Acanthodrilus, Eodrilus* and *Microscolex* are endemic, and of these, *Acanthodrilus* and *Microscolex* are confined to outlying islands of the New Zealand region. On the main islands of New Zealand the Acanthodrilinae are comparatively rare in the extreme north and are dominant in the remainder of the country. A striking parallelism exists between the distribution patterns of genera formerly grouped in the Octochaetinae and genera formerly grouped in the Acanthodrilinae. Pairs of genera are recognisable, differing from each other only in the presence of micronephridia in one and meganephridia in the other. *Octochaetus* is comparable with *Eodrilus, Dinodrilus* with *Eudinodriloides* and *Dinodriloides, Hoplochaetina* with

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Perieodrilus, and *Leucodrilus* with *Rhododrilus*. The significance of these pairs of genera becomes more obvious when their distribution within the region is mapped. The pairs of genera, especially *Octochaetus-Eodrilus* and *Leucodrilus-Rhododrilus*, have almost identical distribution patterns (see distribution maps). This can be taken to indicate that the micronephridial forms are no more than forms derived locally from the corresponding meganephridial genera and cannot be accorded more than generic distinction.

Of the Megascolecinae, none of the genera is endemic. Four genera are confined, within the main islands, to the extreme north, while four are confined to western districts.

From generic definitions which are available in the literature the remainder of the genera of Megascolecidae are integrated with my grouping of the New Zealand genera, as follows:

Octochaetinae:

All of Stephenson's Octochaetinae, together with Gates' *Nelloscolex*, *Killogaster*, *Lennogaster*, and *Tonoscolex* are included in the Acanthodrilinae.

Ocnerodrilinae:

One genus, *Quechua*, resembles *Plutellus*, except that the gizzard is absent. The genus was founded on one specimen (Michaelsen, 1923b) and it is doubtful whether it is distinguishable from *Plutellus*; at most it might be regarded as a separate genus within the subfamily Megascolecinae. With the exception of *Gordiodrilus*, all the remaining genera of the Ocnerodrilinae are referred to the subfamily Acanthodrilinae. There is a strong resemblance between these genera and *Microscolex* and *Eodrilus;* essentially they differ only in the position of the oesophageal glands. Some of the genera could well be combined, e.g. *Kerria* Beddard and *Kerriona* Michaelsen are separated on the grounds that the former is limnic and the latter terrestrial, a habitat difference not normally given generic status; *Malabaria* Stephenson and *Aphanascus* Stephenson, collected at the same time from the same place, are distinguished on the grounds that the former has two pairs of prostatic pores, a pair on xvii and a pair on xix, while the latter has only one pair, on xvii. This is strictly comparable to the case of *Microscolex luykeni* Michaelsen and *M. enzenspergeri* Michaelsen from Possession Id. in the Crozet Is., the former with two pairs and the latter with one pair of prostates; these species are not accorded generic distinction. For the genus *Gordiodrilus*, the writer can only agree with Stephenson (1930, p. 863) that his diagnosis is so indefinite as to be meaningless. The genus has apparently become a convenient repository for species which do not fit into the "family tree".

Gates' genera *Barogaster, Priodochaeta, Priodoscolex, Travoscolides* and *Scolioscolides* are referred to the subfamily Megascolecinae.

The re-grouping of genera here proposed has disadvantages. It makes the subfamily Acanthodrilinae a very large group which is in need of subdivision. However, in the present state of knowledge it is better that it should be possible to refer a species, from its morphology, to a large group of genera than that it should be necessary to be familiar with

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a large and complicated hypothetical "family tree" in order that the correct significance may be attached to those few morphological features which are assumed to be significant.

Subfamily ACANTHODRILINAE

Seventeen genera from the New Zealand region are referred to this subfamily. They include genera formerly referred to the subfamily Acanthodrilinae and the now abandoned subfamily Octochaetinae.

Four New Zealand acanthodriline genera, *Maoridrilus, Plagiochaeta, Neodrilus,* and *Neochaeta,* are distinguished from all other acanthodrilines by the unusual arrangement of the nephridiopores, which alternate, more or less regularly, from a dorso-lateral to a ventro-lateral position in successive segments. Apart from this morphological similarity, the four genera are continuously distributed within an area comprising the southern portion of the North Island and the whole South Island, and they appear to be a distinct natural group. These genera are included in the tribe Neodrilacea. The remainder of the genera formerly included in the Acanthodrilinae, together with the genera formerly included in the subfamily Octochaetinae, are grouped together in the tribe Acanthodrilacea.

Four new genera of Acanthodrilinae are described in this work. One, *Neochaeta,* is referred to the tribe Neodrilacea Stephenson, and three, *Decachaetus, Sylvodrilus,* and *Eudinodriloides,* are referred to the tribe Acanthodrilacea.

Four genera, *Leucodrilus, Octochaetus, Deinodrilus,* and *Hoplochaetina,* formerly referred to the family Octochaetinae because they are micronephridial, are included in the Acanthodrilacea. Although these genera are micronephridial, and in this respect are similar, *Leucodrilus* most closely resembles some species of *Rhododrilus* (especially *R. disparatus,* which has micronephridia as well as meganephridia in the first 20 segments) while the remaining three genera are more similar to *Eodrilus.* The apparent lack of close relationship between *Leucodrilus* and *Octochaetus-Deinodrilus-Hoplochaetina* provides strong evidence that the Octochaetinae as a subfamily has no real existence, and the evidence of the distribution of the genera, mentioned previously, confirms this. It is possible that all the so-called Octochaetinae of New Zealand have been derived from meganephridial acanthodrilines within New Zealand and are not closely related to similar genera outside New Zealand.

The three genera *Acanthodrilus, Eodrilus,* and *Microscolex* are very closely related and *Rhododrilus* is closely related to *Microscolex.* Michaelsen (1900, 1905, 1907a, 1911a, 1913, 1928), Stephenson (1930) and Benham (1909) proposed various ways of dividing the genera, but no satisfactory division was achieved until the work of Pickford (1937) placed the differentiation of the genera on a new basis. Pickford's work was based on South African species, but she also examined a number of species and genera from other regions. She concluded that the genera could best be divided on the presence or absence, and the form, of the nephridial vesicles. In her scheme of classification, *Acan-*

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thodrilus includes those species which, having all the other characters formerly ascribed to *Acanthodrilus,* possess nephridial vesicles of a peculiar "J"-shape and in most cases have the testes enclosed in testis sacs. These species were known only from New Caledonia and the neighbouring island of Maré. *Microscolex* was restricted to species formerly ascribed to that genus which have nephridial vesicles not of the typical *Acanthodrilus* form. *Eodrilus* includes all the remaining species formerly ascribed to *Microscolex* or *Acanthodrilus* in which nephridial vesicles are absent.

The species of the *Acanthodrilus-Eodrilus-Microscolex* group recorded in the present work confirm Pickford's conclusions. One species of Pickford's *Acanthodrilus* is recorded from Raoul Id., in the Kermadec group. This extends the range of the genus, but does not conflict with the distinctness of the genus as a zoogeographical entity. All the endemic species of the group from the mainland of New Zealand and from Snares Is. lack nephridial vesicles and are referred to *Eodrilus.* The species, for which the character has been described, from the subantarctic islands possess nephridial vesicles and they are not of the "J"-shape peculiar to *Acanthodrilus,* so they fall within Pickford's *Microscolex. Microscolex* includes species which have one pair of prostates, opening to the exterior at xvii, in addition to species with two pairs opening to the exterior on xvii and xix, and in this respect these species resemble *Rhododrilus.* In *Rhododrilus,* however, the gizzard is well developed and strong, while in *Microscolex* it is usually absent or very poorly developed.

Benham's genus *Leptodrilus* was differentiated from *Rhododrilus* because the prostatic pores are on xvi instead of xvii. The genus is confined to subantarctic islands. In this bulletin the genus is combined with *Rhododrilus,* since in all other respects the species closely resemble *Rhododrilus* and fall within its area of distribution. Similar variations in the position of the prostatic pores are found in *Neodrilus dissimilis* (described in the present work) and in a South African species, *Udeina kinbergi* (Pickford, 1937, pp. 416–7).

The following is a key for the identification of the New Zealand genera of Acanthodrilinae.

a_1 Meganephridial worms with nephridiopores alternating more or less regularly between dorso-lateral and ventro-lateral positions in successive segments ..... Tribe NEODRILACEA
  b_1 One pair of prostatic pores, on xvii
    c_1 Eight chaetae on each segment ..... NEODRILUS
    c_2 More than eight chaetae on each segment ..... NEOCHAETA
  b_2 Two pairs of prostatic pores, a pair on xvii and a pair on xix
    d_1 Eight chaetae on each segment ..... MAORIDRILUS
    d_2 More than eight chaetae on each segment ..... PLAGIOCHAETA
a_2 Meganephridial worms with nephridiopores in a single series on each side of the body, or micronephridial worms .. Tribe ACANTHODRILACEA
  e_1 Meganephridial
    f_1 Eight chaetae on each segment
      g_1 Two pairs of prostatic pores, a pair on xvii and a pair on xix; gizzard well developed; nephridial vesicles "J"-shaped ..... ACANTHODRILUS
      g_2 Two pairs of prostatic pores, a pair on xvii and a pair on xix; gizzard well developed; nephridial vesicles absent ..... EODRILUS
      g_3 One pair or two pairs of prostatic pores, on xvii, or on xvii and xix; gizzard absent or very weakly developed; nephridial vesicles present but not "J"-shaped ..... MICROSCOLEX

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g_4 One pair of prostatic pores on xvii, gizzard well developed; nephridial vesicles present or absent ..... RHODODRILUS
g_5 One pair of prostatic pores on xix; gizzard well developed; nephridial vesicles present ..... SYLVODRILUS
f_2 Ten chaetae on each segment ..... DECACHAETUS
f_3 Twelve chaetae on each segment
h_1 One pair of prostatic pores, on xvii ..... DINODRILOIDES
h_2 Two pairs of prostatic pores, a pair on xvii and a pair on xix ..... EUDINODRILOIDES
f_4 More than twelve chaetae on each segment ..... PERIEODRILUS
e_2 Micronephridial
j_1 One pair of prostatic pores, on xvii ..... LEUCODRILUS
j_2 Two pairs of prostatic pores, a pair on xvii and a pair on xix
k_1 Eight chaetae on each segment ..... OCTOCHAETUS
k_2 Twelve chaetae on each segment ..... DEINODRILUS
k_3 More than twelve chaetae on each segment ..... HOPLOCHAETINA

Tribe ACANTHODRILACEA

The tribe Acanthodrilacea as understood in this work includes those genera found in New Zealand that were referred by Stephenson (1930) to his Sectio Acanthodrilacea and subfamily Octochaetinae, with the addition of the new genera *Decachaetus, Eudinodriloides,* and *Sylvodrilus* and the previously described genus *Leucodrilus* (Lee, 1952b). Thirteen New Zealand genera are included in the tribe. All are endemic to the New Zealand region except *Acanthodrilus, Eodrilus,* and *Microscolex*. Neither *Acanthodrilus* nor *Microscolex* is endemic on the mainland of New Zealand, the former being confined to the Kermadec Islands and the latter to subantarctic islands within this region.

The genera may be divided into groups which display varying degrees of affinity on systematic and distributional grounds.

The affinities of the *Acanthodrilus-Eodrilus-Microscolex* group have been mentioned previously. *Perieodrilus* may be regarded as derived from or related to *Eodrilus,* since nephridial vesicles are absent in these genera, while they are present in the remaining meganephridial genera of Acanthodrilacea. *Perieodrilus* differs from *Eodrilus* principally in having the perichaetine arrangement of the chaetae, while *Eodrilus* has the lumbricine arrangement. *Perieodrilus* is confined to the south-western corner of the South Island and Snares Is., a distribution pattern paralleled by some species of *Eodrilus*.

Differences between *Rhododrilus* and the biprostatic species of *Microscolex* are small. However, the endemic species of *Microscolex* known from the New Zealand region are all quadri-prostatic and are therefore probably not closely related to *Rhododrilus*. A few species of *Rhododrilus* have no nephridial vesicles, but most species have vesicles. *Decachaetus* and *Eudinodriloides* differ from the quadriprostatic species of *Microscolex* in having, respectively, ten and twelve chaetae on each segment. Both genera tend to have a small or weakly developed gizzard, a character shared with *Microscolex*. *Dinodriloides,* which is biprostatic, meganephridial, and has twelve chaetae on each segment, strongly resembles *Rhododrilus*. Only one species is known and it is found within the northern portion of the distributional range of *Rhododrilus*.

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The remaining genera referred to this tribe are micronephridial. They do not appear to be a homogeneous group. *Leucodrilus* shows closest affinities to *Rhododrilus* in morphology and distribution, *Octochaetus* seems most closely related to *Eodrilus,* while *Deinodrilus* and *Hoplochaetina* may be related to *Octochaetus,* but seem to have close affinities with meganephridial genera, e.g., *Eudinodriloides* and *Perieodrilus.*

Genus ACANTHODRILUS Perrier, emend. Pickford

1872 *Acanthodrilus* Perrier, Nouv. Arch. Mus. Hist. nat., Paris, 8:85.
1899 *Acanthodrilus* (part), Michaelsen, Zool. Jarhb. Syst. 12:237.
1899 *Notiodrilus* (part), Michaelsen, Zool. Jarhb. Syst. 12:239.
1900 *Acanthodrilus* (part), Michaelsen, Tierreich, 10:127.
1900 *Notiodrilus* (part), Michaelsen, Tierreich, 10:128.
1907 *Eodrilus* (part), Michaelsen, Fauna Südwest-Aust. 1(2):141.
1913 *Acanthodrilus* (part), Michaelsen, Nova Caledonia, Zool. 1(3):188.
1930 *Acanthodrilus* (part), Stephenson, Oligochaeta, p. 824.
1937 *Acanthodrilus,* Pickford, Monograph, p. 78.

Chaetae eight on each segment. Prostatic pores two pairs, on xvii, xix; male pores on xviii; in some New Caledonian species the prostatic pores and male pores are one or two segments posterior to the usual positions. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9. Nephridiopores in a single series on each side of the body. Gizzard single, in region of v–vii; well developed. Testes two pairs, in x, xi, frequently in testis sacs. Prostates two pairs, in xvii, xix (in some species xviii, xx, or xix, xxi). Penial chaetae usually present (absent in *A. kermadecensis*?). Spermathecae two pairs, in viii, ix, with or without diverticula. Meganephridial; nephridial vesicles of characteristic "J"-shape present.

Type species: *Acanthodrilus ungulatus* Perrier. New Caledonia.

Number of Species: Twenty; one from the New Zealand region.

Distribution: New Caledonia and surrounding islands; Raoul Id. (Kermadec group).

The history of the genus has been treated extensively by previous workers (Michaelsen, 1900, 1907a, 1913; Stephenson, 1930; Pickford, 1937). Its position in relation to *Microscolex, Eodrilus,* and the now discarded genus *Notiodrilus* has varied from time to time. The definition of the genus of Pickford (1937) is accepted in this work.

Early workers on the New Zealand fauna included in *Acanthodrilus* a number of species which were subsequently referred to *Maoridrilus, Neodrilus, Eodrilus, Microscolex,* and *Octochaetus.* One species, *A. kermadecensis,* is here included in the genus.

Acanthodrilus kermadecensis Lee. Fig. 11

1953 *Acanthodrilus kermadecensis* Lee, Trans. roy. Soc. N.Z. 81: 49–51.

Length 23 mm. Diameter 1·5 mm. 88 segments.
Colour pink with buff clitellum.
Clitellum xiii–xx, dorsal and lateral.
Prostomium tanylobous.
Chaetae 8/segment; ab=bc=cd; dd>aa>ab.

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Prostatic pores on xvii, xix, not on papillae, medial to chaeta a.

Male pores in seminal grooves on xviii, medial to line of prostatic pores.

Female pores on xiv, anterior and medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta d.

No specially thickened septa.

Proventriculus in v. Gizzard in vi–vii. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, undulating. Penial chaetae absent (? The chaetae could not be found, but since the species is so small this does not prove their absence.) Spermathecae in viii, ix; small, laterally flattened, ovoidal sac opening into ovoidal, thick walled atrium; small rounded diverticulum opens by narrow duct into lateral aspect of atrium. (Fig. 11).

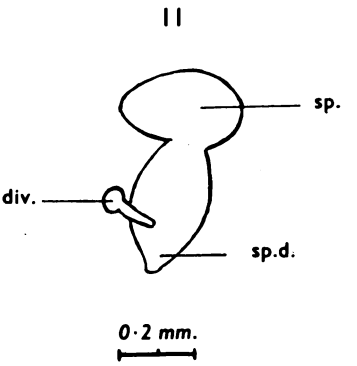

FIG. 11. *Acanthodrilus kermadecensis*. Right posterior spermatheca, lateral aspect

Nephridial vesicles present; "J"-shaped.

Type Locality: Raoul Island; in clump of moss beside fumarole in main crater; A. C. S. Wright, 31/3/49.

Type specimen in Soil Bureau collection.

Localities:

Same data as type material; 3 specimens.

Remarks: A. kermadecensis closely resembles *A. coneensis* Michaelsen, *A. yateensis* Michaelsen, *A. cavaticus* Michaelsen and *A. ungulatus* Perrier, from New Caledonia. The principal differences between these species and *A. kermadecensis* have been set out previously (Lee, 1953).

Genus DECACHAETUS n.g.

Small, darkly pigmented worms, inhabiting litter or peat. Chaetae 10/segment. Clitellum developed over xiv–xvii, dorsal and lateral. Prostatic pores two pairs, on xvii, xix, on small, rounded papillae. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9, ventro-lateral. Nephridiopores in a single lateral series on each side of the body. Gizzard single, in v or vi. Dorsal blood vessel paired; four pairs of hearts, the last pair in xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates two pairs, in xvii, xix, tubular. No penial chaetae nor copulatory muscles. Spermathecae two pairs, in viii, ix; each spermatheca with two diverticula in the same segment as the sac. Meganephridial; nephridial vesicles present.

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Type species: *Decachaetus violaceus* n.sp.

Number of Species: Two.

Distribution: West coast of South Island and Stewart Island, New Zealand. (Fig. 356).

The genus is established for two new species which closely resemble *Microscolex* but differ from that genus principally in having ten chaetae on each segment, while *Microscolex* has eight.

KEY TO THE SPECIES OF DECACHAETUS

a_1 Strong thick walled gizzard in v; intestine commencing in xvi; vesiculae seminales of xii sac-like ..... **D. minor**

a_2 Thin walled gizzard in vi; intestine commencing in xv; vesiculae seminales of xii racemose ..... **D. violaceus**

The two species are very similar and can only be distinguished by small differences of colour and anatomy (Table 1). Each is known from only one locality (*D. minor* near Reefton; *D. violaceus* from Stewart Island). Both species have been recorded from forest soils and may be survivors of a formerly more widespread fauna which has

TABLE 1. Decachaetus

——	*minor*	*violaceus*
Length	30 mm.	35 mm.
Diameter	1·75 mm.	2 mm.
Segments	105	89
Colour	brown	violet
Clitellum	xiv–xvii	xiv–xvii
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	epilobous	epilobous
Prostatic papillae	present	present
Position of prostatic pores ..	b	b
Position of male pores ..	in seminal grooves lateral to b	in seminal grooves medial to b
Position of female pores ..	antero-medial to b	anterior to b
Position of spermathecal pores ..	7/8, 8/9; b	7/8, 8/9; b
Position of nephridiopores ..	c	c
Septal thickening	absent	absent
Proventriculus	absent	absent
Gizzard	v (strong)	vi (thin walled)
Oesophageal glands	absent	dilated in viii, ix
1st intestinal segment ..	xvi	xv
Dorsal blood vessel	paired	paired
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xii	ix, xii
Form of ves. sem.	sac	ix sac; xii racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	viii, ix	viii, ix
Spermathecal diverticula:		
Number	2	2
Form	long, tubular	slender, pyriform
Position	1 anterior, 1 posterior	1 lateral, 1 medial
Nephridial vesicles	present	present

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been reduced and restricted to isolated localities which retained a forest cover during the recent glacial period.

Decachaetus minor n.sp. Figs. 12–14.

Length 30 mm. Diameter 1·75 mm. 105 segments.

Colour brown, with prominent paler brown clitellum.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 10/segment; ab=cd=de; aa=bc=ee>ab.

Prostatic pores on small rounded papillae on xvii, xix, in position of chaeta b. Male pores in seminal grooves on xviii, slightly lateral to chaeta b.

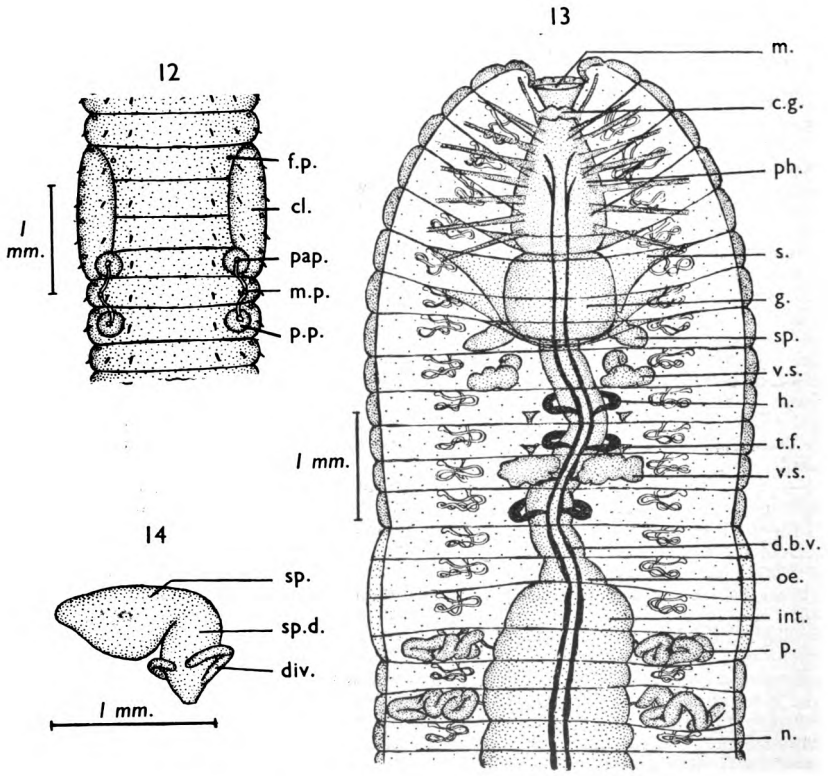
Female pores on xiv, anterior and slightly medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Pharynx in i–iv, thin walled, and covered dorsally and laterally by masses of down-like salivary glands. Gizzard in v, well developed.



FIGS. 12–14. *Decachaetus minor* n.sp.
12. Ventral aspect, segments xiii–xx
13. Dissection from dorsal aspect, segments i–xxi
14. Left anterior spermatheca, medial aspect

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Oesophagus has thin, almost transparent walls and lacks glands. Limits of oesophagus and intestine difficult to determine, but intestine appears to commence in xvi.

Dorsal blood vessel paired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes and ovaries not recorded. Paired funnels present in x, xi, which probably correspond to testes; no funnels seen in xiii. Vesiculae seminales in ix, xii; compact sac-like organs. Prostates in xvii, xix, convoluted and tubular; prostatic ducts long, narrow and not strongly muscular. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; ovoidal sac, set at sharp angle to thick muscular duct; two long tubular diverticula arise from the distal region of the duct, one anterior and one posterior, and curve around the medial aspect of the duct. (Fig. 14).

Nephridia with small vesicles.

Type Locality: Reefton Saddle; in leaf mould under *Nothofagus fusca* and *N. menziesii;* K.E.L., 7/1/52.

Type specimen in Soil Bureau collection.

Localities:

Same data as type material; 5 specimens.

Decachaetus violaceus n.sp. Figs. 15–17

Length 35 mm. Diameter 2 mm. 89 segments.

Colour violet dorsally, pale and unpigmented ventrally.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 10/segment. Posterior to clitellum chaetae almost evenly spaced around periphery of segments; anterior to clitellum chaetae a and b and chaetae c and d are in pairs while chaeta e is unpaired. On viii the arrangement is: aa=bc=de>cd; cd>ab; ee>aa. On xxiv the arrangement is: ab=bc=cd=de; ee>aa>ab.

Prostatic pores on xvii, xix, on rounded papillae, in position of chaeta b.

Male pores on xviii in seminal grooves, between chaetae a and b (closer to b than to a).

Female pores on xiv, slightly anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Unpaired tuberculum pubertatis lies across ventral mid-line of xiii, from chaeta b to chaeta b.

No specially thickened septa.

Pharynx in i–v. Gizzard in vi, thin walled. Oesophagus dilated in viii, ix. Intestine commences in xv.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Testes and ovaries consist of clusters of thread-like processes. Vesiculae seminales in ix, xii; those of ix small and sac-like, those of xii larger and racemose. Prostates in xvii, xix, coiled and tubular. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; short, truncated conical sac lying under the

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oesophagus and opening to the exterior by a wide duct; two small slender pyriform diverticula, one lateral and one medial, open into the spermathecal duct. (Fig. 17).

Nephridia with vesicles.

Type Locality: Beside Mason Bay Track, Stewart Id.; in a peat bog; A. C. S. Wright, Dec. 1950.

Type specimen in Soil Bureau collection.

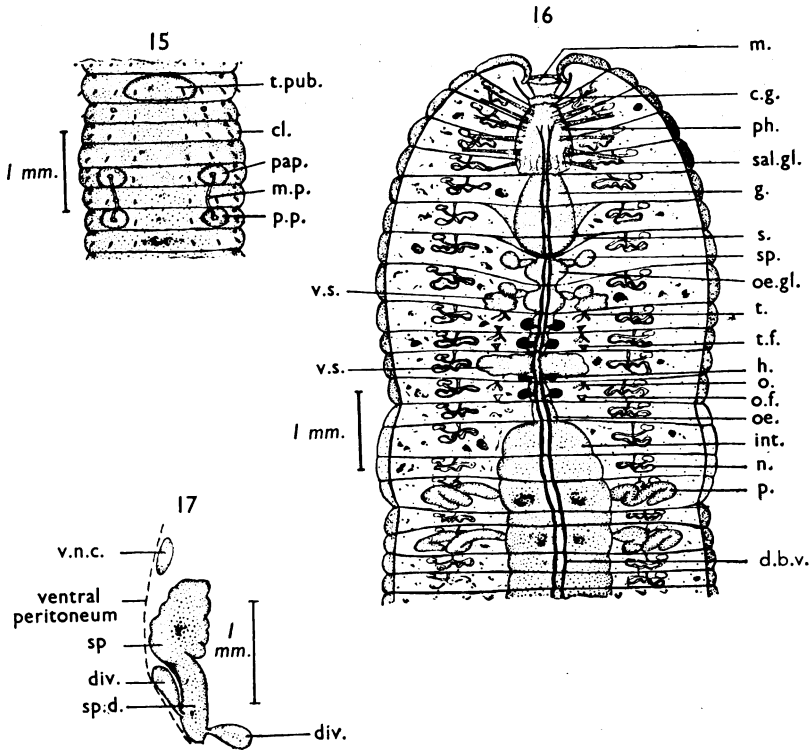
Localities:

Same data as type material; 1 specimen.

Genus DEINODRILUS Beddard

1889 *Deinodrilus* Beddard, Quart. J. micr. Sci. 29:105.
1900 *Dinodrilus,* Michaelsen, Tierreich, 10:321.
1920 *Dinodrilus,* Michaelsen, Mitt. zool. Mus. Hamb. 38:37.
1930 *Dinodrilus,* Stephenson, Oligochaeta, p. 845.
1945 *Dinodrilus* + *Conicodrilus* Benham, Trans. roy. Soc. N.Z. 75:23.
1952 *Dinodrilus,* Lee, Trans. roy. Soc. N.Z. 79:563.

Chaetae 12/segment. Clitellum developed over at least three segments between xii and xix. Prostatic pores two pairs, on papillae, on xvii, xix.



FIGS. 15–17. *Decachaetus violaceus* n.sp.
15. Ventral aspect, segments xiii–xx
16. Dissection from dorsal aspect, segments i–xxi.
17. Left posterior spermatheca, anterior aspect

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Male pores in seminal grooves on xviii. Female pores on xiv, paired, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9, ventro-lateral. Gizzard single, strongly developed, in v or vi or vi–vii. Dorsal blood vessel paired, the two vessels fusing at the intersegmental septa in some species; four pairs of hearts, a pair each in x, xi, xii, xiii. Testes in x, xi (in *D. suteri* there are testicular funnels in xi, but the corresponding testes are absent), not in testis sacs. Prostates two pairs, in xvii, xix, each confined to a single segment; tubular. Penial chaetae absent. Spermathecae two pairs, in viii, ix, each with three or more diverticula in the same segment. Micronephridia numerous in each segment, sometimes concentrated in a pair of small ventro-lateral tufts in each segment.

Type species: *Deinodrilus benhami* Beddard, 1889.

Number of Species: Eight.

Distribution: New Zealand; confined to the northern and western districts of the North Island and western districts of the South Island. (Fig. 357).

This genus was established by Beddard (1889) for a New Zealand species, *D. benhami.* Michaelsen (1900) changed the spelling of the generic name from *Deinodrilus,* as spelt by Beddard, to *Dinodrilus.* There appears to have been no reason for this change, and though the spelling *Dinodrilus* has been used since 1900, it is incorrect and the original spelling must stand.

Benham (1945) established a genus, *Conicodrilus,* for two species of *Deinodrilus.* His genus resembled *Deinodrilus* in all respects except that the prostatic papillae were long, slender and conical instead of low and rounded. The conical form of the papillae cannot be regarded as a reliable taxonomic character, and Lee (1952b) re-united the two species with *Deinodrilus.*

One new species, *D. lateralis,* is described in this work.

KEY TO THE SPECIES OF DEINODRILUS

a₁ Gizzard in v
  b₁ Dorsal blood vessel paired throughout its length ..... **D. parvus**
  b₂ Dorsal blood vessel paired, but the two vessels fusing at each intersegmental septum, at least anterior to xiii
    c₁ Vesiculae seminales one pair, in xi ..... **D. suteri**
    c₂ Vesiculae seminales two pairs, in xi, xii ..... **D. lateralis**
a₂ Gizzard in vi or vi–vii
  d₁ Oesophageal glands absent
    e₁ Spermatheca with three diverticula, one one side, two other side of duct ..... **D. benhami**
    e₂ Spermatheca with five diverticula arranged in ring around duct ..... **D. montanus**
  d₂ Oesophageal glands present
    f₁ Intestine commencing in xvii ..... **D. agilis**
    f₂ Intestine commencing in xix
      g₁ Septa vii/viii to xiv/xv thickened and strongly muscular ..... **D. gracilis**
      g₂ Septal thickening absent ..... **D. kanieriensis**

The eight known species of *Deinodrilus* are distributed throughout the length of the North and South Islands, but are confined to districts west of the main mountain divide.

Two species, *D. lateralis* and *D. suteri,* are distinct from the remainder (see Table 2) in having the micronephridial tubules concentrated

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TABLE 2. Deinodrilus

——	*agilis*	*benhami*
Length	105 mm.	125 mm.
Diameter	4 mm.	4–5 mm.
Segments	154	150–160
Colour	red-brown	pink
Clitellum	xiii–xvi	xiv–xvi
Extent of clitellum	complete	complete
Prostomium	epilobous	epilobous
Prostatic papillae	prominent, domed	flat
Position of prostatic pores ..	b	b
Position of male pores ..	a/b, in seminal grooves	b/c, in seminal grooves
Position of female pores ..	antero-medial to b	antero-medial to a
Position of spermathecal pores	7/8, 8/9 b	7/8, 8/9 b
Septal thickening	absent	viii/ix–xii/xiii
Proventriculus	v	v
Gizzard	vi	vi–vii
Nature of gizzard	strong	strong
Oesophageal glands	ix, x, xi, xii, xiii	absent
1st intestinal segment ..	xvii	?
Dorsal blood vessel	paired	paired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	dorsal and supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	xi, xii racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	present	?
Spermathecal diverticula:		
Number	4	3
Form	digitate	ovoidal
Position	1 anterior 3 posterior	1 lateral 1 medial
Nephridia	numerous lateral	numerous lateral

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TABLE 2. Deinodrilus—*continued*

gracilis	*kanieriensis*	*lateralis*	*montanus*
90 mm.	170 mm.	85 mm.	55 mm.
3 mm.	4 mm.	4 mm.	4 mm.
120	200	120–130	109
pale grey	dark brown	pink	pink
½xiii–½xvi	½xiii–xvi	xiv–xix	xiii–xvi
complete	complete	dorsal and lateral	dorsal and lateral
tanylobous	epilobous	epilobous	epilobous
high, nipple shaped	high, nipple shaped	prominent, conical	prominent, rounded
b	b	a/b	b
b/c, in seminal grooves	b/c, in seminal grooves	a/b, in seminal grooves	b/c, in seminal grooves
anterior to b	close to ventral mid-line	anterior to a	antero-medial to a
7/8, 8/9 b	7/8, 8/9 a	7/8, 8/9 a	7/8, 8/9 lateral to a
viii/ix–xiv/xv	absent	vi/vii–xii/xiii	absent
v	v	v	v
vi–vii	vi	v	vi
strong	strong	strong	strong
xiv, xv, xvi	xviii	ix, x, xi	absent
xix	xix	xiii	xviii
paired	paired	paired, but fusing at septa	paired
4	4	4	4
xiii	xiii	xiii	xiii
dorsal b.v.	supra-intest. b.v.	supra-intest. b.v.	supra-intest. b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii	xi, xii
racemose	botryoidal	racemose	racemose
xvii, xix	xvii, xix	xvii, xix	xvii, xix
absent	absent	absent	absent
present	present	present	absent
5–6	4	numerous	5
digitate	digitate	1 flat, rest digitate	digitate
surround	surround	1 anterior, rest	surround
duct	duct	posterior and lateral	duct
numerous	numerous	ventro-lateral	ventro-lateral
lateral	lateral	tufts	and lateral

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TABLE 2. Deinodrilus—*continued*

——	*parvus*	*suteri*
Length	32·5 mm.	230–250 mm.
Diameter	4 mm.	7–10 mm.
Segments	113	180–200
Colour	pink	pink
Clitellum	xii–xvi	xiv–xviii
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	epilobous
Prostatic papillae	prominent, rounded	prominent, conical
Position of prostatic pores ..	a/b	b
Position of male pores ..	a/b, in seminal grooves	b/c, in seminal grooves
Position of female pores ..	anterior to a	anterior to a
Position of spermathecal pores	7/8, 8/9 a/b	7/8, 8/9 b
Septal thickening	viii/ix–xiii/xiv	v/vi–xiii/xiv
Proventriculus	absent	absent
Gizzard	v	v
Nature of gizzard	strong	strong
Oesophageal glands	absent	xvi, xvii
1st intestinal segment ..	xviii	xviii
Dorsal blood vessel	paired	paired, but fusing at septa ant. to xiii
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi racemose	xi racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	absent	present
Spermathecal diverticula:		
Number	6	7
Form	globular	globular
Position	anterior and lateral	surround duct
Nephridia	ventro-lateral–dorso-lateral	ventro-lateral tufts

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in dense ventro-lateral tufts in each segment, while the remainder have the tubules more widely scattered. These two species show a close relationship to *D. parvus* in that the gizzard in the three species is in v, while in the remaining species of the genus it is in vi or vi–vii. *D. suteri* and *D. parvus* also resemble each other in having only one pair of vesiculae seminales, in xi, while the remainder of the species of the genus have two pairs, in xi and xii. The significance of these similarities is enhanced by the distribution of the species, since these three species are confined to North Auckland and are widely separated geographically from the remaining species of the genus. The remaining five species are continuously distributed in western districts of the North and South Islands, Kapiti Island and Stephen Island. They may be divided into two groups on the basis of the same characters used for the first three species. *D. agilis, D. montanus,* and *D. kanieriensis* all have the proventriculus in v, gizzard in vi, and two pairs of vesiculae seminales in xi and xii. In addition these species have no septal thickening, while all other species of the genus have some of the anterior septa thickened and muscular. *D. agilis* and *D. montanus* are North Island species, the latter being widely distributed, while *D. kanieriensis* is found in the north-west of the South Island. *D. benhami* and *D. gracilis* have a proventriculus in v, gizzard in vi–vii, two pairs of vesiculae seminales, in xi and xii, and have some of the anterior septa thickened. *D. benhami* is confined to the west of the South Island, while *D. gracilis* is found in the north-west of the South Island, Stephen Island, Kapiti Island and the south-west of the North Island.

The distribution of the genus illustrates how unimportant Cook Strait has been in the determination of the present distribution pattern of earthworms. This is further illustrated and discussed more fully in the discussion of the distribution of *Maoridrilus*.

Deinodrilus agilis Lee. Fig. 18

1952 *Dinodrilus agilis* Lee, Trans. roy. Soc. N.Z. 79:566.

Length 105 mm. Diameter 4 mm. 154 segments.

Colour reddish brown dorsally, pale ventrally, with very prominent sienna-brown clitellum.

Clitellum xiii–xvi, complete.

Prostomium epilobous.

Chaetae 12/segment, in equidistantly spaced pairs; ab=cd=ef; aa=bc=de=ff>ab.

Prostatic pores on prominent dome-like papillae on xvii, xix, in position of chaetae b.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, antero-medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

No specially thickened septa.

Proventriculus in v, short, wide, thin walled. Gizzard in vi. Oesophageal glands in ix, x, xi, xii, xiii. Intestine commences in xvii.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

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Testes in x, xi, compact. Ovaries in xiii, compact. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; small cylindrical sac with narrow duct; four, curved, digitate diverticula open into duct, one anteriorly, three posteriorly. (Fig. 18).

Large numbers of micronephridia form a compact mat on the lateral aspects of the peritoneum in each segment except i.

Type Locality: Kaingaroa Forest, 5 miles E. of Waiotapu; topsoil, pine forest; K.E.L. 6/10/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen.

Deinodrilus benhami Beddard. Fig. 19

1889 *Deinodrilus benhami* Beddard, Quart. J. micr. Sci. 29:105.
1889 *Deinodrilus benhami,* Beddard, Proc. zool. Lond., 1889, p. 379
1890 *Deinodrilus benhami,* Benham, Quart. J. micr. Sci. 31:232.
1891 *Deinodrilus Benhami,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1893 *Deinodrilus benhami,* Smith, Trans. N.Z. Inst. 25:119–22.
1894 *Deinodrilus benhami,* Smith, Trans. N.Z. Inst. 26:157.
1895 *Deinodrilus benhami,* Beddard, Monograph, p. 557.
1900 *Dinodrilus benhami,* Michaelsen, Tierreich, 10:321.
1905 *Dinodrilus benhami,* Ude, Z. wiss. Zool. 83.
1945 *Dinodrilus benhami,* Benham, Trans. roy. Soc. N.Z. 75:26.
1952 *Dinodrilus benhami,* Lee, Trans. roy. Soc. N.Z. 79:563.

Length 125 mm. Diameter 4–5 mm. 150–160 segments.

Colour pink.

Clitellum xiv–xvi, complete.

Prostomium epilobous.

Chaetae 12/segment, approximately equally spaced except for wider dorsal and ventral gaps.

Prostatic pores on xvii, xix, on round flattened papillae, in position of chaeta b.

Male pores in seminal grooves on xviii, between chaetae b and c.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa viii/ix–xii/xiii moderately thickened.

Proventriculus in v. Gizzard in vi–vii. Oesophageal glands absent. Limits of oesophagus and intestine not recorded.

Dorsal blood vessel paired. Hearts in x, xi, xii, xiii, connected to dorsal and supra-intestinal blood vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Spermathecae in viii, ix; oval sac with long narrow duct; three small oval diverticula, one on one side, two on the other, at junction of sac and duct. (Fig. 19).

Micronephridia numerous on lateral aspects of peritoneum.

Type Locality: Lake Brunner District, South Island; F. E. Beddard 1889.

Type (?) specimen in British Museum (Nat. Hist.) collection registration no. 1904. 10.

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Localities:

South Island: Caswell Sound; topsoil, beech forest; R. R. Forster, 14/4/49; 4 specimens.

Deinodrilus gracilis Ude

1905 *Dinodrilus gracilis* Ude, Z. wiss. Zool. 83.
1919 *Dinodrilus gracilis,* Benham, Trans. N.Z. Inst. 51:34.
1945 *Conicodrilus gracilis,* Benham, Trans. roy. Soc. N.Z. 75:26.
1952 *Dinodrilus gracilis,* Lee, Trans. roy. Soc. N.Z. 79:563.

Length 90 mm. Diameter 3 mm. 120 segments.

Colour pale grey, with pale brown clitellum.

Clitellum ½xiii–½xvi, complete.

Prostomium tanylobous.

Chaetae 12/segment; ab=cd; bc=de=ef>ab; ff>aa.

Prostatic pores on xvii, xix, on high nipple-shaped papillae in line with chaeta b; the papillae overlap onto xviii, from front and rear, and their points almost touch.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa viii/ix–xiv/xv thickened.

Gizzard in vi–vii. Oesophagus somewhat dilated in xiv, xv, xvi. Intestine commences in xix.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, coiled and flattened. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; large ovoidal sac with short duct; six (in one case recorded by Ude only 5) small digitate diverticula around top of duct.

Micronephridia numerous, on lateral aspects of peritoneum.

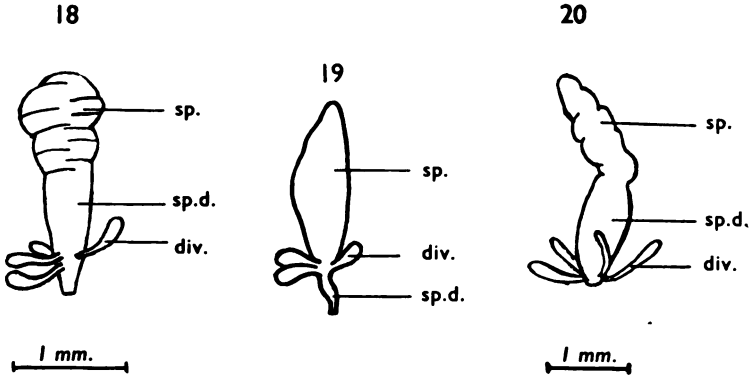

FIG. 18. *Deinodrilus agilis.* Left posterior spermatheca, medial aspect
FIG. 19. *Deinodrilus benhami.* Spermatheca. (After Beddard, 1889a)
FIG. 20. *Deinodrilus kanieriensis.* Spermatheca. (After Benham, 1945)

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Type Locality: Stephen Island, Cook Strait; H. Ude 1905.
Type material of this species has not been located.

Localities:

North Island: N.E. side of Mt. Wainui, Paekakariki; under stones broadleaved forest; K.E.L., 18/11/53; 1 specimen.
Kapiti Island: Beside track to Kapiti Trig, 1400 ft.; topsoil, coastal forest; K.E.L., 26/1/54; 1 specimen. Beside track to Kapiti trig, 1300 ft.; topsoil, coastal forest; K.E.L., 26/1/54; 1 specimen.
South Island: Kaiteriteri Beach, near Motueka; small pockets of soil on very steep hillside above beach, beech forest; K.E.L., 27/5/54; 15 specimens. Takaka Hill, near Motueka; small pockets of soil between limestone boulders, beech forest; K.E.L., 27/5/54; 1 specimen.

Remarks: A number of specimens found under beech forest (*N. solandri*) at Kaiteriteri and Takaka Hill, near Motueka, have been referred to this species. They vary from the type description in possessing one pair of oesophageal glands, in xvi, but otherwise closely resemble it. They are not considered sufficiently distinct to justify the establishment of a new species or subspecies.

Deinodrilus kanieriensis (Benham). Fig 20

1945 *Conicodrilus kanieriensis* Benham, Trans. roy. Soc. N.Z. 75:23–8.
1952 *Dinodrilus kanieriensis,* Lee, Trans. roy. Soc. N.Z. 79:563.

Length 170 mm. Diameter 4 mm. About 200 segments
Colour reddish brown with pale brown clitellum.
Clitellum ½xiii–xvi, complete.
Prostomium epilobous.

Chaetae 12/segment, approximately equidistant. (Benham's specimens had only 8 chaetae/segment anterior to the clitellum, but all my specimens have had 12).

Prostatic pores on xvii, xix, on very prominent pointed papillae which project across xviii like those of *D. gracilis;* the papillae on each side of the body are connected by a very prominent ridge, curving laterally across xviii.

Male pores in seminal grooves (which run along ridges mentioned above) on xviii, lateral to chaeta b.

Female pores on xiv, close to anterior margin and to ventral midline.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

No specially thickened septa.

Gizzard in vi. Oesophageal glands in xviii. Intestine commences in xix.

Dorsal blood vessel paired. Supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii, xix, tightly coiled and tubular. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; cylindrical sac with long wide duct; four slender digitate diverticula around proximal end of duct. (Fig. 20).

Micronephridia numerous; in a line near anterior septum of each segment.

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Type Locality: Lake Kanieri, Westland; W. B. Benham, 1945.

Type material in Otago Museum (No. A.44.85); 2 specimens and fragments, well preserved.

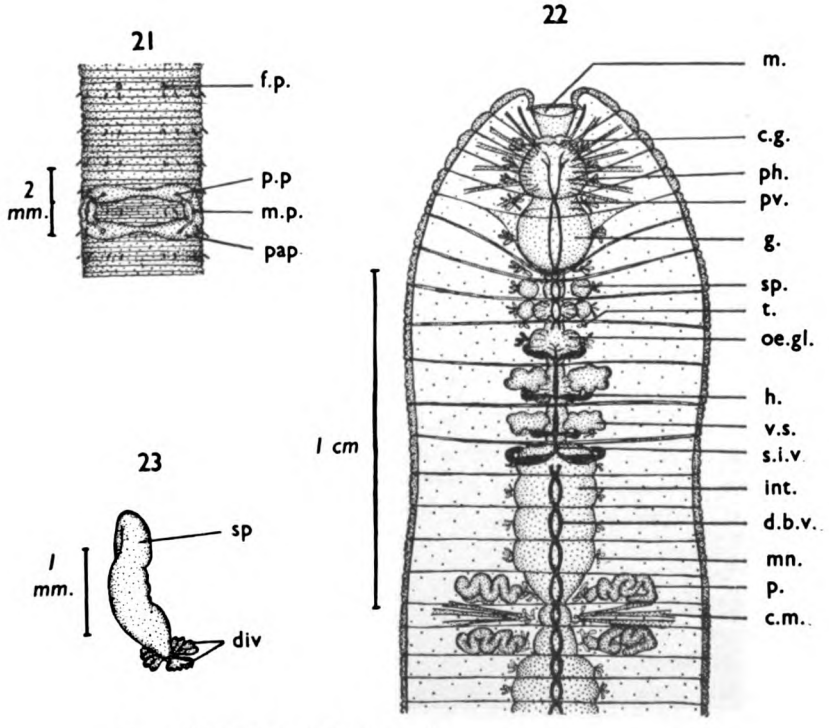
Localities:

South Island: Maimai, near Reefton; topsoil, rough pasture; K.E.L., 7/1/52; 1 specimen. Inangahua; topsoil, beech forest; K.E.L., 7/1/52; 4 specimens. Mabelle Bay, Westland; topsoil, coastal forest; K.E.L., 8/1/52; 1 specimen. Punakaiki Stream, Westland; topsoil, coastal forest; K.E.L., 8/1/52; 2 specimens. Dobson, near Greymouth; leaf mould, beech forest; K.E.L., 7/1/52; 1 specimen. Greymouth; topsoil, scrub; K.E.L., 8/1/52; 4 specimens. Marsden, near Hokitika; topsoil, podocarp forest; K.E.L., 8/1/52; 1 specimen. Rimu, Westland; topsoil, manuka scrub; K.E.L., 9/1/52; 4 specimens. Rimu State Forest, near Hokitika; subsoil, pine forest; K.E.L., 15/1/53; 2 specimens. Rimu State Forest; topsoil, manuka scrub; K.E.L., 15/1/53; 1 specimen. Lake Mahinapua Forest Reserve; topsoil, podocarp forest; K.E.L., 16/1/53; 3 specimens. Ferguson's Bush, Westland; topsoil, podocarp forest; K.E.L., 9/1/52; 1 specimen. Duffer's Creek, near Ross; topsoil, podocarp forest; K.E.L., 9/1/52; 3 specimens.

Deinodrilus lateralis n.sp. Figs. 21–23

Length 85 mm. Diameter 4 mm. 120–130 segments; i–iv without secondary annulations, v biannulate, vi triannulate, vii quadriannulate, remainder of segments quinquiannulate.

Colour pale pink.



FIGS. 21–23. *Deinodrilus lateralis* n.sp.
21. Ventral aspect, segments xiv–xx
22. Dissection from dorsal aspect, segments i–xxi
23. Right posterior spermatheca, anterior aspect

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Clitellum xiv–xix, dorsal and lateral.

Prostomium epilobous.

Chaetae 12/segment, in pairs; ab=ef>cd; aa=bc=de; ff>aa>ab.

Prostatic pores on xvii, xix, on very prominent conical papillae, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta a; each surrounded by narrow ridge.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa vi/vii–xii/xiii thickened and muscular.

Pharynx in i–iv. Short proventriculus in v, opening into strong gizzard, also in v. Oesophageal glands in ix, x, xi, containing hard calciferous concretions. Intestine commences in xiii; laterally compressed in xvii–xix by prostates and copulatory muscles.

Dorsal blood vessel paired, but two vessels fuse at each septum. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, small and compact. Ovaries in xiii, small and compact. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, convoluted and tubular. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; long tubular sac with narrow duct; diverticula numerous—one flattened fan-shaped diverticulum on anterior aspect and a number of small, digitate diverticula on posterior and lateral aspects of spermathecal duct. (Fig. 23).

Micronephridia concentrated in small ventro-lateral tufts, one on each side of each segment.

Type Locality: Prescott's Road, near Ruakaka, Northland; subsoil, "gumland"; K.E.L., 24/7/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 6 specimens. White Cone, near Whangarei; subsoil, podocarp-broadleaved forest; K.E.L., 25/7/51; 3 specimens. Ruatangata West, near Whangarei; topsoil, podocarp forest; K.E.L., 26/7/51; 1 specimen.

Deinodrilus montanus Lee. Fig. 24

Length 55 mm. Diameter 4 mm. 109 segments.

Colour pink with a red streak along the mid-dorsal line from posterior border of clitellum to anus. Clitellum darker than adjacent segments.

Clitellum xiii–xvi, complete.

Prostomium epilobous.

Chaetae 12/segment, almost evenly spaced; ab=bc=cd=de=ef; ff>aa>ab.

Prostatic pores on xvii, xix, in position of chaeta b, on prominent rounded papillae.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, slightly lateral to line of chaeta a.

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No specially thickened septa.

Proventriculus in v. Gizzard in vi. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii, each consisting of a group of moniliform threads. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, very long and convoluted. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; antero-posteriorly compressed conical sac with narrow duct; five small digitate diverticula grouped around base of sac and opening into duct. (Fig. 24).

Micronephridial tubules in a band across ventro-lateral and lateral aspects of each side of each segment.

Type Locality: Rimutaka Range, N. of Wellington; topsoil, beech forest; K.E.L., 19/4/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Mangawhahariki Gorge, near Mangaweka; topsoil, beech forest; K.E.L., 13/10/50; 2 specimens. Mt. Egmont, 3,800 ft.; topsoil, subalpine forest; K.E.L., 12/5/50; 4 specimens. Mt. Egmont, 4,700 ft.; topsoil, tussock; K.E.L., 12/5/50; 4 specimens. Manganui Hut, Mt. Egmont; under rocks, herb field; J. S. Edwards, 11/51; 1 specimen. Douglas, Taranaki; topsoil, broadleaved forest; K.E.L., 13/5/50; 9 specimens. Whangamomona, Taranaki; topsoil, broadleaved forest; K.E.L., 13/5/50; 1 specimen. Whangamomona, Taranaki; topsoil, rough pasture; K.E.L., 13/5/50; 2 specimens. Ohura; topsoil, broadleaved forest; K.E.L., 13/5/50; 1 specimen. Waituhi Trig, 3,075 ft., central North Island; topsoil, moss, grasses; K.E.L., 14/5/50; 8 specimens. Chateau Tongariro; topsoil, beech forest; K.E.L., 15/5/50; 1 specimen. Raurimu; topsoil, tussock; K.E.L., 15/5/50; 3 specimens, Raurimu, topsoil, podocarp forest; K.E.L., 15/5/50; 2 specimens. Waitaia Stream, W. Taupo; topsoil, podocarp forest; A. C. S. Wright, 8/1/50; 1 specimen. Ngaroma, near Arapuni; topsoil, podocarp-broadleaved forest; K.E.L., 25/5/50; 1 specimen.

Deinodrilus parvus Lee. Fig 25

1952 *Dinodrilus parvus* Lee, Trans. roy. Soc. N.Z. 79:563–4.

Length 32·5 mm. Diameter 4 mm. 113 segments.

Colour pale pink with slightly darker clitellum.

Clitellum xii–xvi, complete.

Prostomium tanylobous.

Chaetae 12/segment, in pairs; ab=cd=ef; bc=de>ab; aa=ff>bc.

Prostatic pores on xvii, xix, in line with chaetal interval ab, on prominent rounded papillae.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Septa viii/ix–xiii/xiv thickened and muscular.

Gizzard in v, strong. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi, lobed. Ovaries in xiii, lobed. Vesiculae seminales in xi, racemose. Prostates in xvii, xix, tubular and convoluted. No penial

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chaetae nor copulatory muscles. Spermathecae in viii, ix; small ovoidal sac with narrow duct; six small globular diverticula surround anterior and lateral aspects of spermathecal duct close to sac. (Fig. 25).

Micronephridial tubules in a line across ventral to dorso-lateral aspects of peritoneum in each segment.

Type Locality: Near summit of Mangamuku Ra., S. of Kaitaia; subsoil, podocarp-broadleaved forest; K.E.L., 23/3/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 5 specimens.

Deinodrilus suteri Benham. Fig. 26

1906 *Dinodrilus suteri* Benham, Trans. N.Z. Inst. 38:243–4.
1945 *Dinodrilus suteri*, Benham, Trans. roy. Soc. N.Z. 75:26.
1952 *Dinodrilus suteri*, Lee, Trans. roy. Soc. N.Z. 79:563.

Benham's original description was based on very small immature specimens. In the diagnosis below, further details have been derived from specimens in my collection.

Length 230–250 mm. Diameter 7–10 mm. 180–200 segments; i–iii without secondary annulations; iv–vii biannulate; remainder of segments triannulate.

Colour pink with purplish clitellum.

Clitellum xiv–xviii; complete on xiv–xvi, dorsal and lateral on xvii–xviii.

Prostomium epilobous.

Chaetae 12/segment, almost equidistant: bc=cd=de=ef; ff>aa>bc>ab.

Prostatic pores on xvii, xix, in position of chaeta b, on very prominent conical papillae.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa v/vi–xiii/xiv thickened and muscular.

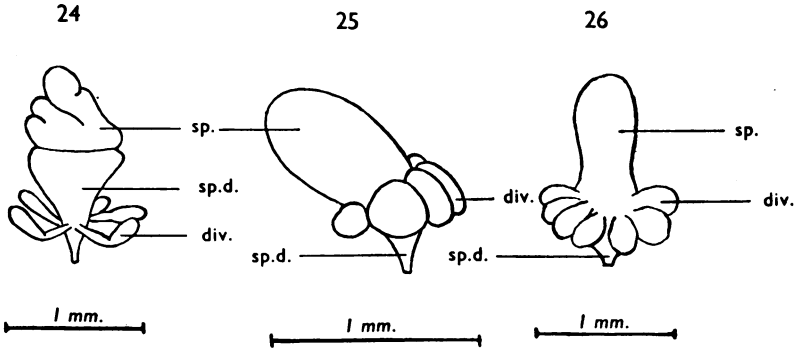

FIG. 24. *Deinodrilus montanus*. Right posterior spermatheca, anterior aspect
FIG. 25. *Deinodrilus parvus*. Right anterior spermatheca, lateral aspect
FIG. 26. *Deinodrilus suteri*. Spermatheca. (After Benham, 1906b)

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Gizzard in v, large and strong. Oesophageal glands in xvi, xvii. Intestine commences in xviii.

Dorsal blood vessel paired; in anterior region the two vessels fuse at septa; posterior to xii/xiii they remain distinct. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x; funnels but no testes present in xi. Ovaries in xiii. Vesiculae seminales in xi, racemose. Prostates in xvii, xix, coiled, tubular. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; simple ovoidal sac with wide short duct; seven small globular diverticula clustered around duct. (Fig. 26).

Micronephridial tubules in small ventro-lateral tufts.

Type Locality: Swanson; W. B. Benham, 1905.

Type material in Otago Museum (No. A.43.38); 1 specimen, dissected and bisected anteriorly, well preserved.

Localities:

North Island: Leigh, Northland; subsoil, coastal forest; K.E.L., 27/7/51; 2 specimens. Waitakere Ra., Auckland; subsoil, kauri-podocarp forest; K.E.L., 29/7/51; 2 specimens. Huia Stm., Waitakere Ra., subsoil, forest; J. S. Edwards, 14/4/52; 1 specimen.

Genus DINODRILOIDES Benham

1904 *Dinodriloides* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 226.
1907 *Dinodriloides,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1930 *Dinodriloides,* Stephenson, Oligochaeta, p. 825.
1937 *Dinodriloides,* Pickford, Monograph, p. 89.

Chaetae 12/segment. Clitellum developed over xiv–xvi. Prostatic pores one pair, on xvii, on papillae. Seminal grooves present. Male pores at anterior margin of xviii, at end of seminal grooves. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores one pair, ventro-lateral, at 8/9. Nephridiopores in a single lateral series on each side of the body. Gizzard single, in vi. Dorsal blood vessel paired; four pairs of hearts, the last pair in xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates one pair in xvii, tubular. No penial chaetae nor copulatory muscles. Spermathecae one pair, in ix, each with two diverticula in the same segment as the sac. Nephridial vesicles present.

Type species: *Dinodriloides beddardi* Benham 1904.

Number of Species: One.

Distribution: North Island of New Zealand, confined to northern portion of island and to some offshore islands. (Fig. 358).

The genus was proposed by Benham (1904b) for a species from Auckland which resembles *Rhododrilus* except that it has twelve chaetae on each segment, while *Rhododrilus* has eight. A second species, *D. annectens,* was described by Benham (1906a), from Little Barrier Island. For reasons stated under the diagnosis of the remaining species, *D. beddardi, D. annectens* is not regarded as a distinct species.

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Dinodriloides beddardi Benham. Fig. 27

1904 *Dinodriloides beddardi* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 220.
1905 *Dinodriloides beddardi,* Benham, Trans. N.Z. Inst. 37:282.
1906 *Dinodriloides annectens,* Benham, Trans. N.Z. Inst. 38:251–2.
1907 *Dinodriloides annectens,* Michaelsen, Fauna Südwest-Aust. 1 (2):143.
1907 *Dinodriloides Beddardi,* Michaelsen, Fauna Südwest-Aust. 1 (2):143.
1937 *Dinodriloides annectens,* Pickford, Monograph p. 89.
1937 *Dinodriloides beddardi,* Pickford, Monograph p. 89.
1952 *Dinodriloides annectens,* Lee, Trans. roy. Soc. N.Z. 79:537.
1952 *Dinodriloides beddardi,* Lee, Trans. roy. Soc. N.Z. 79:537.

Length 78 mm. Diameter 4 mm. 95 segments.

Colour bluish grey with brown clitellum; chaetae on prominent yellowish spots.

Clitellum xiv–xvi; complete on xiv–½xv, dorsal and lateral on ½xv–xvi, or sometimes complete over xiv–xvi.

Prostomium epilobous.

Chaetae 12/segment, practically equidistant.

Prostatic pores one pair, on xvii, on papillae, in position of chaeta b, which is displaced laterally.

Male pores at termination of seminal grooves near anterior margin of xviii, anterior to chaetal interval bc.

Female pores one pair, on xiv, anterior to chaetal interval ab.

Spermathecal pores at 8/9, in line with chaetal interval bc.

Nephridiopores in line with chaeta d.

No specially thickened septa.

Gizzard in vi, small. Oesophagus dilated in xiv, xv, xvi. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii; tubular and tightly coiled. No penial chaetae nor copulatory muscles. Spermathecae in ix; sub-globular sac with muscular duct; two long tubular diverticula opening into lateral aspect of duct. (Fig. 27). Nephridial vesicles present.

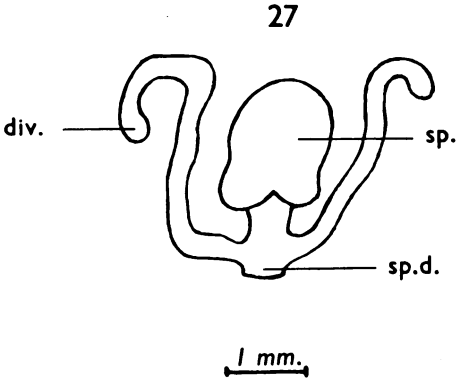

FIG. 27. *Dinodriloides beddardi.* Spermatheca. (After Benham, 1904b)

Type Locality: Auckland; W. B. Benham, 1905.

Type material in Otago Museum (No. A.43.37); 1 specimen, in poor condition, could not be removed from container due to risk of damage.

Localities:

North Island: Waimatenui, near Whangarei; leaf mould, broadleaved forest; K.E.L., 18/1/49; 4 specimens. Waitaia Stm., W. Taupo; ex rotten log; A. C. S. Wright, 7/1/50; 2 specimens. Waitaia Stm., W. Taupo; topsoil, podocarp forest; A. C. S. Wright, 7/1/50; 1 specimen. National Park; topsoil, podocarp forest;

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K.E.L., 15/5/50; 1 specimen. Whatawhata, W. Waikato; topsoil, fern; K.E.L., 18/5/50; 4 specimens. Mairoa, W. Waikato; topsoil, broadleaved forest; K.E.L., 26/5/50; 1 specimen. Waitakere Ra., near Auckland; topsoil, kauri forest; K.E.L., 28/7/51; 1 specimen. Nugget's Lookout, Waitakere Ra.; ex rotten log; J. S. Edwards, 12/4/52; 1 specimen. Anawhata Gorge, Waitakere Ra.; ex rotting manuka stem; J. S. Edwards, 24/5/52; 1 specimen.

Offshore Islands: Little Barrier Island, near foreshore; under stones; J. S. Edwards, May 1954; 1 specimen. Taranga (Hen Id.); under log; H. S. Fairburn, August 1953; 1 specimen.

Remarks: Benham (1906a) proposed a species *D. annectens* for specimens collected from forest on Little Barrier Island. Benham's specimens differ from the type description in the following respects:

Slightly greater size

Genital pores slightly displaced laterally on segments

Tubercula pubertatis differ.

None of these characters is sufficiently invariable to be accorded specific significance, so I have combined *D. annectens* with *D. beddardi.* Type material of *D. annectens* is in the Otago Museum (No. A.06.54). There is one, well preserved specimen, which Benham has labelled "type of genus". This cannot be correct, however, since *D. beddardi* was described before *D. annectens.*

Genus Eodrilus Michaelsen, emend. Pickford.

1907 *Eodrilus* (part) Michaelsen, Fauna Südwest-Aust. 1 (2) :141.
1913 *Acanthodrilus* (part) Michaelsen, Nova Caledonia, Zool. 1 (3) :188.
1930 *Acanthodrilus* (part) Stephenson, Oligochaeta p. 824.
1937 *Eodrilus* Pickford, Monograph p. 99.

Eodrilus as a generic name has had various connotations since it was first established by Michaelsen (1907a). Pickford (1937) reconstituted the genus and her definition is used in the present work.

Chaetae 8/segment. Prostatic pores two pairs, on xvii, xix. Male pores one pair on xviii, or rarely at 17/18. Spermathecal pores two pairs at 7/8, 8/9, ventro-lateral, or rarely median ventral pores at 5/6, 6/7, 7/8, 8/9. Nephridiopores in a single series on each side of the body. Gizzard single, in region of v–viii; well developed, reduced or rudimentary. Testes two pairs, in x, xi, not in testis sacs. Nephridia without terminal vesicles. Penial chaetae usually absent in New Zealand species.

Type species: *Eodrilus cornigravei* Michaelsen 1907. Cannington, W. Australia.

Number of Species: Fifty, including nine from the New Zealand region.

Distribution: Australia, New Zealand, Snares Islands, Chile, South Patagonia, South Africa, Madagascar, Cameroons, Central America (?).

Of the nine species of *Eodrilus* recorded from the New Zealand region two have been collected from the south-west of the North Island, five from the South Island and two from Snares Islands (Fig. 359). With the exception of *E. paludosus,* which is fairly widely distributed in the east of the South Island, the species are restricted to small areas.

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TABLE 3. Eodrilus

——	*annectens*	*fallax*
Length	70–110 mm.	175 mm.
Diameter	c. 3 mm.	11 mm.
Segments	122	142
Colour	pink & white	dark brown
Clitellum	xiii–xx	xiv–xix
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	prolobous	epilobous
Prostatic papillae	prominent	rounded
Position of prostatic pores ..	b	b
Position of male pores	in seminal grooves	medial to a in semina grooves
Position of female pores ..	antero-medial to a	antero-lateral to a
Position of spermathecal pores ..	7/8, 8/9 b	7/8, 8/9 b
Position of nephridiopores ..	d	c
Septal thickening	vii/viii–xi/xii	ix/x–xiii/xiv
Proventriculus	absent	v
Gizzard	v	vi
Nature of gizzard	strong	strong
Oesophageal glands	absent	xiii, xiv
1st intestinal segment ..	xx	xviii
Dorsal blood vessel	paired	paired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	dorsal b.vv.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	ix, xii racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	present	absent
Spermathecal diverticula:		
Number	4	2
Form	small	small, glomerulate
Position	anterior	1 anterior 1 posterior
Nephridial vesicles	absent	absent

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TABLE 8. Eodrilus—*continued*

haplocystis	*micros*	*montanus*
290 mm.	35 mm.	41·5 mm.
6 mm.	2 mm.	2·75 mm.
200	126	122
orange-brown	pale brown	pink
xiii–xix(xx)	xiii–xvii	xiii–xix
dorsal and lateral	xiii–xvi complete xvii dors. and lat.	xiii–xvi complete xvii–xix dors./lat.
epilobous	epilobous	epilobous
rounded	absent	very prominent
b	a	b
lateral to b in seminal grooves	a/b in seminal grooves	lateral to b in seminal grooves
anterior to b	anterior to a	anterior to a
7/8, 8/9 b	7/8, 8/9 b	7/8, 8/9 b
b	b	c
vii/viii–xiv/xv	absent	absent
part v	v	v
part v–vi	vi	vi
large, strong	long, strong	large, strong
xiv, xv, xvi	xvi	xvi
xx	xviii	xvii
paired	paired, but fusing at septa	paired
4	4	4
xiii	xiii	xiii
dorsal b.vv.	dorsal b.vv.	supra-intest. v.
x, xi	x, xi	x, xi
ix, x, xii racemose	ix, xii racemose	ix, xi, xii racemose
xvii, xix	xvii, xix	xvii, xix
absent	present	absent
absent	absent	present
absent	1	3
..	small, ovoidal	small, slender, pyriform
..	medial	2 anterior 1 posterior
absent	absent	absent

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TABLE 3. Eodrilus—*continued*

——	*pallidus*	*paludosus*
Length	50 mm.	25 mm.
Diameter	2·5 mm.	1 mm.
Segments	143	?
Colour	pink	pink
Clitellum	xiii–xvii	½xiii–½xix
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	tanylobous
Prostatic papillae	prominent	rounded
Position of prostatic pores ..	anterior to b	lateral to b
Position of male pores	lateral to b in seminal grooves	lateral to b in seminal grooves
Position of female pores ..	antero-lateral to a	anterior to a
Position of spermathecal pores ..	7/8, 8/9 b	7/8, 8/9 b
Position of nephridiopores ..	c	d
Septal thickening	absent	vii/viii–xi/xii
Proventriculus	v	absent
Gizzard	vi	v–vi
Nature of gizzard	long, strong	strong
Oesophageal glands	xv, xvi	absent
1st intestinal segment ..	xviii	xx
Dorsal blood vessel	paired	paired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	supra-intest. v.	supra-intest. v.
Testes	x, xi	x, xi
Vesiculae seminales	xii sac sperms in x, xi	ix, xi, xii racemose
Prostates	xvii→, xix→	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	present	present
Spermathecal diverticula:		
Number	2	2
Form	small, slender, pyriform	irregular, lobed
Position	1 lateral 1 medial	1 anterior 1 posterior
Nephridial vesicles	absent	absent

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TABLE 3. Eodrilus—*continued*

parvus	*rossi*
23 mm.	144 mm.
1·25 mm.	5·5 mm.
85	162
greyish brown	pink
¼xiii–¼xvii	xiii–½xviii
complete	dorsal and lateral
prolobous	tanylobous
prominent	prominent
lateral to b	b
lateral to b in seminal grooves	lateral to b in seminal grooves
antero-lateral to b	antero-medial to a
7/8, 8/9 lateral to b	7/8, 8/9 b
b	c
absent	vii/viii–xi/xii
absent	part v
v	part v
short, strong	long, strong
dilated in xiv–xviii	xvi
xix	xviii
paired	paired
4	4
xiii	xiii
dorsal b.v.	dorsal b.v. and supra-intest. b.v.
x, xi	x, xi
ix, xii	xi, xii racemose sperms in x, xi
xvii, xix	xvii, xix
absent	absent
present	absent
2	2
slender, pyriform	small, ovoid
1 lateral	1 anterior
1 medial	1 posterior
absent	absent

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The distribution of the genus parallels that of *Maoridrilus* but is on a more restricted scale.

Differences between the species (see Table 3) are small, but numerous, and there does not seem to be any pattern of morphological relationship which can be related to the present distribution of the species.

KEY TO THE NEW ZEALAND SPECIES OF EODRILUS

a1 Gizzard wholly anterior to septum v/vi
  b1 Vesiculae seminales two pairs, in xi, xii
    c1 Oesophageal glands absent; copulatory muscles present ..... **E. annectens**
    c2 Oesophageal glands one pair, in xvi; copulatory muscles absent ..... **E. rossi**
  b2 Vesiculae seminales two pairs in ix, xii; x, xi filled with loose sperms ..... **E. parvus**
a2 Gizzard wholly or partly posterior to septum v/vi
  d1 Oesophageal glands absent ..... **E. paludosus**
  d2 Oesophageal glands present
    e1 Copulatory muscles absent
      f1 Vesiculae seminales two pairs, in ix, xii
        g1 Spermathecae each with two glomerulate diverticula, one anterior and one posterior ..... **E. fallax**
        g2 Spermathecae each with one small, ovoidal, medial diverticulum ..... **E. micros**
      f2 Vesiculae seminales three pairs, in ix, x, xii ..... **E. haplocystis**
    e2 Copulatory muscles present
      h1 Vesiculae seminales one pair, in xii; x and xi filled with loose sperms ..... **E. pallidus**
      h2 Vesiculae seminales three pairs, in ix, xi, xii ..... **E. montanus**

Eodrilus annectens (Beddard). Fig. 28

1889 *Acanthodrilus annectens* Beddard, Quart. J. micr. Sci. 29:101.
1889 *Acanthodrilus annectens,* Beddard, Proc. zool. Soc. Lond., 1889, p. 378.
1889 *Acanthodrilus annectens,* Beddard, Quart. J. micr. Sci. 29:242.
1890 *Acanthodrilus annectens,* Beddard, Quart. J. micr. Sci. 30:425.
1890 *Acanthodrilus annectens,* Beddard, Quart. J. micr. Sci. 31:230.
1890 *Acanthodrilus annectens,* Beddard, Proc. zool. Soc. Lond., 1890, p. 59.
1891 *Acanthodrilus annectens,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Acanthodrilus annectens,* Beddard, Proc. zool. Soc. Lond., 1892, p. 672.
1893 *Acanthodrilus annectens,* Smith, Trans. N.Z. Inst. 25:122–4.
1894 *Acanthodrilus annectens,* Smith, Trans. N.Z. Inst. 26:157.
1895 *Acanthodrilus annectens,* Beddard, Monograph p. 536.
1900 *Notiodrilus annectens,* Michaelsen, Tierreich 10:184.
1901 *Acanthodrilus annectens,* Benham, Trans. N.Z. Inst. 33:132.
1901 *Acanthodrilus annectens,* Benham, Quart. J. micr. Sci. 44:565–90.
1907 *Eodrilus annectens,* Michaelsen, Fauna Südwest-Aust. 1 (2):141.
1937 *Eodrilus annectens,* Pickford, Monograph p. 87.

I have not collected any specimens of this species, but have examined a named specimen from the collections of Sir William Benham.

Length 70–110 mm. Diameter about 3 mm. 122 segments, multiannulate.

Colour variegated pink and white with yellowish clitellum.

Clitellum xiii–xx, dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment, paired, pairs widely spaced.

Prostatic pores on prominent papillae on xvii, xix, in line with chaeta b.

Male pores in seminal grooves, on xviii, lateral to chaeta b.

Female pores on xiv, antero-medial to chaeta a.

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Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridial pores in line with chaeta d.

Septa vii/viii to xi/xii slightly thickened.

Proventriculus in anterior portion of v. Gizzard in v. Oesophageal glands lacking. Intestine commences in xx.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi, on posterior septum of segment, adjacent to funnels. Ovaries in xiii, arranged the same as testes. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular and coiled. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; elongate narrow sac; four small diverticula open into anterior aspect of duct. (Fig. 28).

Nephridia without vesicles.

Type Locality: Canterbury Plains; F. E. Beddard, 1889.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Other Records:

Canterbury Plains; tussock land in moist earth near watercourses and swamps; W. W. Smith, 1887.

Eodrilus fallax (Benham). Fig. 29

1909 *Notiodrilus fallax* Benham, Subant. Is. N.Z. 1:268.
1937 *Eodrilus fallax,* Pickford, Monograph, p. 87.

Length 175 mm. Diameter 11 mm. 142 segments.

Colour dark chocolate brown with very dark brown clitellum.

Clitellum xiv–xix, dorsal and lateral.

Chaetae 8/segment; ab=cd; aa>bc>ab; dd ≫ aa.

Prostatic pores on papillae on xvii, xix, in position of chaeta b.

Male pores in seminal grooves, medial to chaeta a, on xviii.

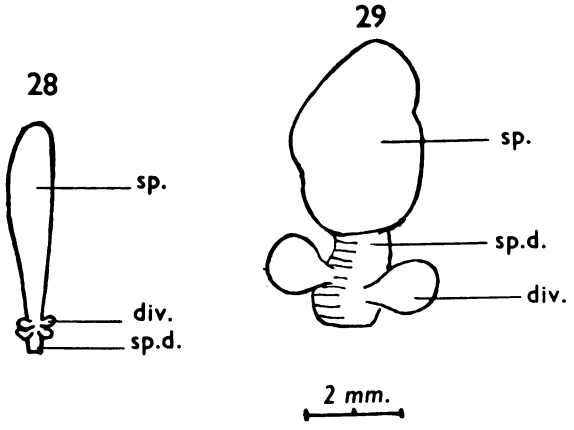

FIG. 28. *Eodrilus annectens.* Spermatheca. (After Beddard, 1889a)

FIG. 29. *Eodrilus fallax.* Spermatheca. (After Benham, 1909)

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Female pores on xiv, antero-lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Septa ix/x–xiii/xiv thickened.

Gizzard in vi. Oesophageal glands in xiii, xiv. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts (from dorsal blood vessels?) in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, xix; compressed, coiled, tubular. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; irregular ovoidal sac with thick duct; two small glomerulate diverticula open into anterior and posterior aspects of spermathecal duct, close to distal end. (Fig. 29).

Nephridia very small. Nephridial vesicles absent.

Type Locality: Snares Island; under stones and in soil; W. B. Benham, 1909.

Type (?) material in Otago Museum (No. A.56.32); 2 specimens, both bisected anteriorly, well preserved.

Eodrilus haplocystis (Benham).

1901 *Acanthodrilus haplocystis* Benham, Trans. N.Z. Inst. 33:130–2
1907 *Eodrilus haplocystis,* Michaelsen, Fauna Südwest-Aust. 1 (2):141.
1909 *Notiodrilus haplocystis,* Benham, Subant. Is. N.Z. 1:270.
1937 *Eodrilus haplocystis,* Pickford, Monograph p. 87.

Length 290 mm. Diameter 6 mm. 200 segments; anterior segments quadriannulate, post-clitellar triannulate.

Colour orange-brown, with a darker ring around the posterior half of each segment behind the clitellum.

Clitellum xiii–xix(xx), dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment; ab=cd; aa>bc>ab; dd ≫ aa.

Prostatic pores on xvii, xix, on papillae, in line with chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta b.

Septa vii/viii–xiv/xv thickened and muscular.

Gizzard in part v and vi. Oesophageal glands in xiv, xv, xvi. Intestine commences in xx.

Dorsal blood vessel paired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xii, racemose; those of ix, x, smaller than those of xii. Prostates thick, convoluted, tubular and compressed, in xvii, xix. Penial chaetae absent. Copulatory muscles absent. Spermathecae in viii, ix; simple ovoidal sac, proximal portion more muscular than distal portion, with no definite duct; diverticula absent.

Nephridia without vesicles.

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Type Locality: Snares Is.; W. B. Benham 1901. Type material in Otago Museum (No. A.56.26); 2 specimens, well preserved.

Other Records:
Snares Is.; W. B. Benham 1909.

Eodrilus micros n.sp. Figs. 30–32.

Length 35 mm. Diameter 2 mm. 126 segments.

Colour pale brown.

Clitellum xiii–xvii, very prominent; complete on xiii–xvi, dorsal and lateral on xvii.

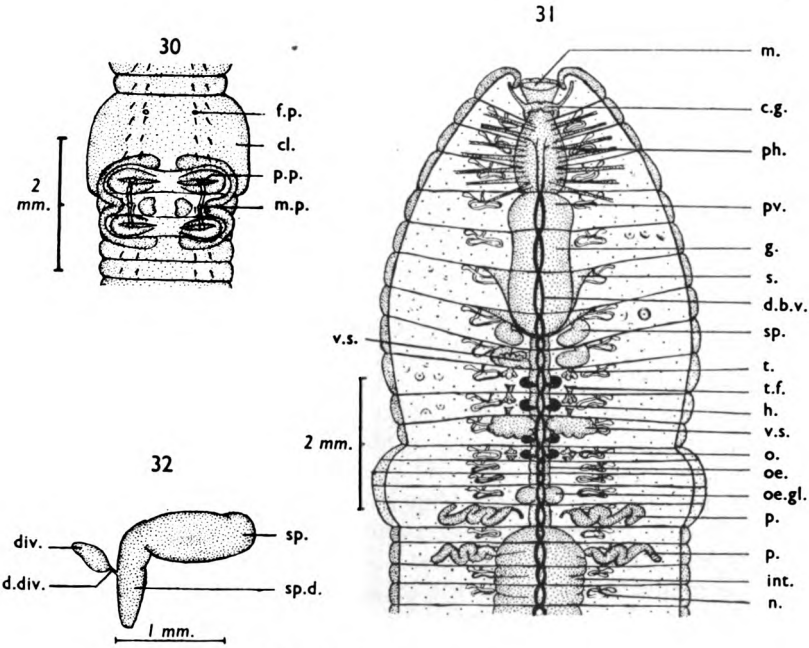
Prostomium epilobous.

Chaeta 8/segment: aa=bc>cd>ab; dd>aa.

Prostatic pores on xvii, xix, in line with chaeta a, surrounded by thick tumid lips.

Male pores in seminal grooves on xviii, between chaetae a and b. Prominent continuous ridge commences close to ventral mid-line on each side of xvi, runs laterally across xvi, curves around tumid lips of prostatic pores on xvii, runs medially across xviii to chaeta b, reverses across xviii, runs around tumid lips of prostatic pore of xix, medially onto xx and terminates near the ventral mid-line on xx (see Fig. 30). Viewed from the ventro-lateral aspect the ridge is shaped like the letter "W".

Female pores on xiv, anterior to chaeta a.



FIGS. 30–32. *Eodrilus micros* n.sp.
30. Ventral aspect, segments xiii–xxi
31. Dissection from dorsal aspect, segments i–xxi
32. Left anterior spermatheca, anterior aspect

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Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta b.

No specially thickened septa.

Small proventriculus in v. Long gizzard in vi. Oesophageal glands in xvi. Intestine commences in xviii.

Dorsal blood vessel paired, but the two vessels fuse at each septum. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi, small and compact. Ovaries in xiii, small, thin, laminar. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, xix, convoluted and tubular. Penial chaetae present; very small, slender, curved shaft, sharply pointed, without ornamentation. Spermathecae in viii, ix; long, laterally directed, tubular sac, at right angles to the thick muscular spermathecal duct; small ovoidal diverticulum opens by very narrow duct into medial aspect of spermathecal duct. (Fig. 32).

Nephridial vesicles absent.

Type Locality: Terrace above Mangawharariki Stm. between Mangaweka and Rangiwahia; topsoil, beech forest; K.E.L., 13/10/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 6 specimens.

Eodrilus montanus n.sp. Figs. 33–35

Length 41·5 mm. Diameter 2·75 mm. 122 segments; segments biannulate.

Colour pale pink with pale yellow-brown clitellum; body wall unpigmented.

Clitellum xiii–xix; complete on xiii–xvi, dorsal and lateral on xvii–xix.

Prostomium epilobous.

Chaetae 8/segment: ab=bc; aa=cd; dd≫aa>ab.

Prostatic pores on xvii, xix, on very prominent papillae, in position of chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Pharynx in i–iv. Proventriculus in v, thin walled. Gizzard in vi, large and muscular. Oesophageal glands in xvi. Intestine commences in xvii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel passes through ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, small and compact. Ovaries in xiii, small, moniliform. Vesiculae seminales in ix, xi, xii, racemose; those of ix smaller than those of xi, xii. Prostates in xvii, xix, long, tubular, convoluted. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; large ovoidal sac with short wide muscular duct; three small, slender, pyriform diverticula open into spermathecal duct, two anteriorly and one posteriorly, close to base of sac. (Fig. 35).

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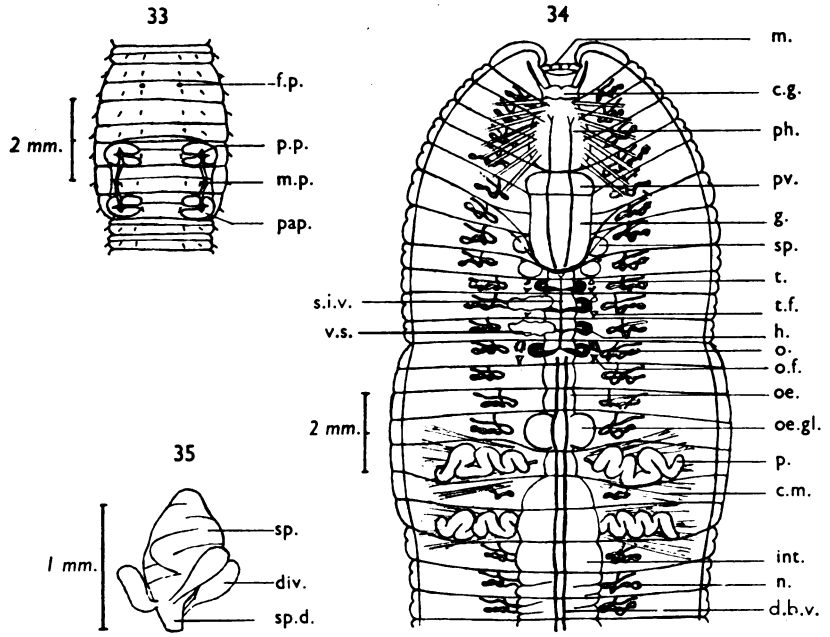

FIGS. 33–35. *Eodrilus montanus* n.sp.
33. Ventral aspect, segments xii–xxi
34. Dissection from dorsal aspect, segments i–xxii.
35. Left posterior spermatheca, posterior aspect

Nephridial vesicles absent.

Type Locality: Top of peak on S. side of Lindis Pass (4,100 ft.); topsoil, snow tussock; K.E.L., 11/10/53.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 12 specimens. S. side of Lindis Pass, 4,000 ft.; topsoil, snow tussock; K.E.L., 21/10/53; 6 specimens. McKenzie Plains, 7 miles S. of L. Pukaki; topsoil, fescue tussock; K.E.L., 18/10/53; 3 specimens.

Eodrilus pallidus n.sp. Figs. 36–38

Length 50 mm. Diameter 2·5 mm. 143 segments.

Colour pink.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc; dd>aa>ab.

Prostatic pores on prominent white papillae on xvii, xix, slightly anterior to chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior and slightly lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

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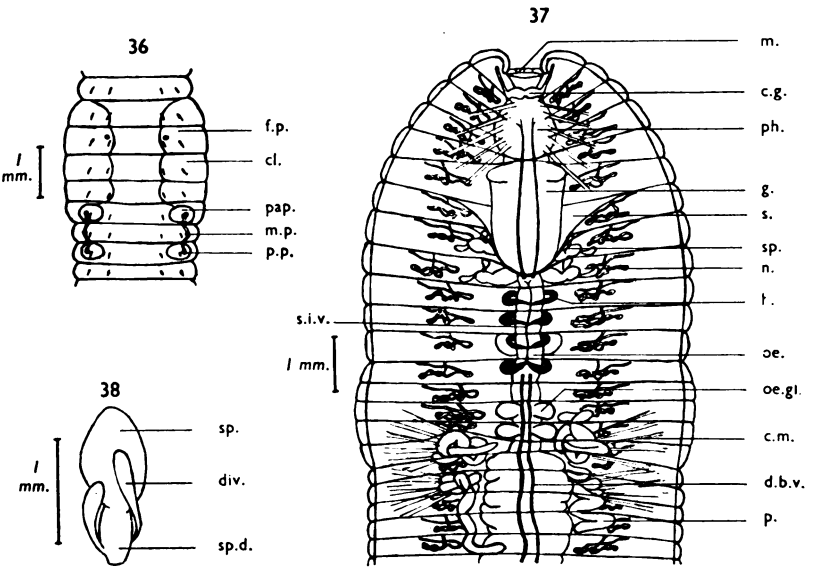

FIGS. 36–38. *Eodrilus pallidus* n.sp
36. Ventral aspect, segments xii–xx
37. Dissection from dorsal aspect, segments i–xxii
38. Right anterior spermatheca, anterior aspect

No specially thickened septa.

Pharynx in i–iv. Proventriculus in v, short, wide, thin walled. Gizzard in vi, long and muscular. Oesophageal glands in xv, xvi. Intestine commences in xviii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, compact. Ovaries in xiii, compact. Vesiculae seminales in xii, sac-like; coelomic cavity of x, xi, filled with loosely packed mass of sperms. Prostates originating from ducts in xvii, xix, tubular, convoluted; not confined to one segment as is usual in this genus, but extending through 2–4 segments. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; large ovoidal sac opening by wide duct to exterior; two small, slender, pyriform diverticula arise, one laterally and one medially, from the spermathecal duct and project forwards. (Fig. 38).

Nephridia lack vesicles.

Type Locality: Soil Bureau Experimental Station, Lower Hutt; topsoil under scrub; K.E.L., 19/7/54.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 9 specimens. Taita; leaf mould under scrub; K.E.L., 4/5/54; 2 specimens. Stokes Valley; topsoil, scrub; W. T. Ward, 1952; 2 specimens.

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Eodrilus paludosus (Beddard). Fig. 39.

1892 *Acanthodrilus paludosus* Beddard, Proc. zool. Soc. Lond., 1892, p. 677.
1894 *Acanthodrilus paludosus,* Smith, Trans. N.Z. Inst. 26:173–5.
1895 *Acanthodrilus paludosus,* Beddard, Monograph p. 536.
1895 *Acanthodrilus paludosus,* Beddard, Proc. zool. Soc. Lond., 1895, p. 213.
1900 *Notiodrilus paludosus,* Michaelsen, Tierreich 10:134.
1901 *Acanthodrilus paludosus,* Benham, Trans. N.Z. Inst. 33:132.
1907 *Eodrilus paludosus,* Michaelsen, Fauna Südwest-Aust. 1 (2):141.
1937 *Eodrilus paludosus,* Pickford, Monograph p. 87.

Length about 25 mm. Diameter about 1 mm.

Colour pale pink or transparent; buff clitellum.

Clitellum ½xiii–½xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment, paired, pairs widely spaced.

Prostatic pores on xvii, xix, on papillae, in position of chaeta b.

Male pores on xviii, in seminal grooves, lateral to chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta d.

Septa vii/viii–xi/xii muscular and thickened.

Gizzard in part v–vi. Oesophageal glands absent. Intestine commences in xx.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii. Testes in x, xi, on posterior septum of segments (like *E. annectens*). Ovaries in xiii, on posterior septum. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii, xix, convoluted and tubular. Penial chaetae absent.

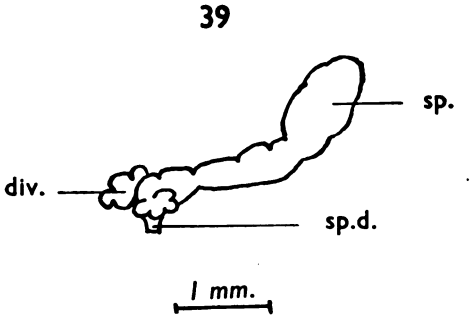

FIG. 39. *Eodrilus paludosus*. Left anterior spermatheca, antero-lateral aspect. (After Beddard, 1892b)

Copulatory muscles present. Spermathecae in viii, ix; ovoidal sac with wide duct; two irregular lobed diverticula open into spermathecal duct, one anteriorly and one posteriorly. (Fig. 39).

Nephridial vesicles absent. Anterior nephridia modified to form "mucus gland" opening into pharynx.

Type Locality: Canterbury Plains; in a marsh; F. E. Beddard 1892.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Localities:

South Island: Fraser's Dam Rd., Old Man Ra., Central Otago; topsoil, fescue tussock; K.E.L., 12/10/53: 3 specimens. Fraser's Dam Rd., Central Otago; topsoil, *Raoulia;* K.E.L., 12/10/53; 1 specimen. Ward, Marlborough; subsoil, pasture; K.E.L., 29/5/54; 8 specimens. Awatere Valley, Marlborough; topsoil, broadleaved forest; K.E.L., 30/5/54; 9 specimens.

Previous Records:

South Island: Albury, Canterbury Plains; W. W. Smith, 1893; under tussock. Canterbury Plains; W. B. Benham, 1901.

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Eodrilus parvus n.sp. Figs. 40–42.

Length 23 mm. Diameter 1·25 mm. 85 segments.

Colour greyish brown with brown clitellum (in alcohol).

Clitellum xiv–xvi, overlapping slightly onto xiii and xvii; complete.

Prostomium prolobous.

Chaetae 8/segment: ab=bc=cd; dd>aa>ab.

Prostatic pores on prominent dome-like papillae on xvii, xix, slightly lateral to chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

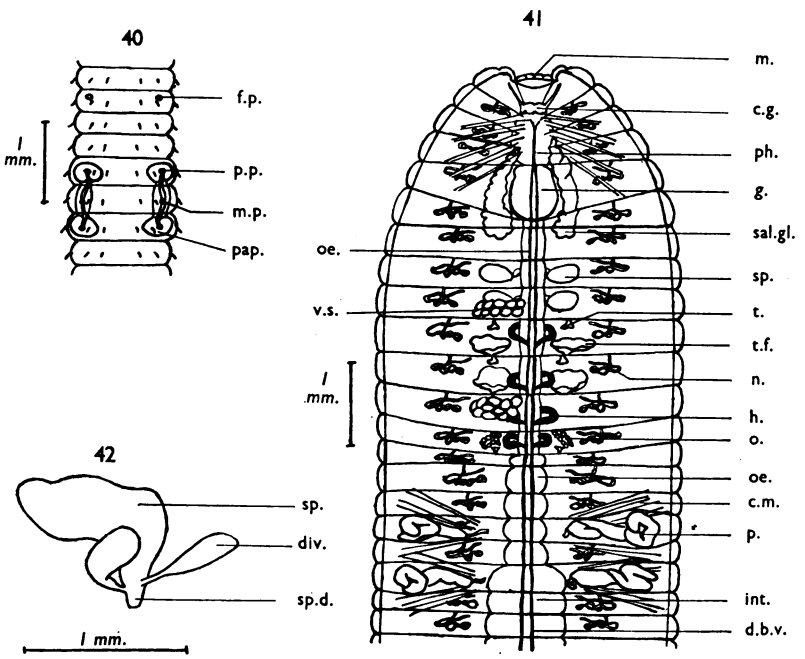
Female pores on xiv, slightly anterior and lateral to chaeta b.

Spermathecal pores at 7/8, 8/9, slightly lateral to line of chaeta b.

Nephridiopores in line with chaeta b, but are not visible externally and can only be located from the point of entry of the nephridial duct into the body wall internally.

No specially thickened septa.

Pharynx in i–iv; salivary glands cover pharynx and extend back beside gizzard. Gizzard in v, short and wide. Oesophagus is slightly dilated in xiv–xviii. Intestine commences in xix.



FIGS. 40–42. *Eodrilus parvus* n.sp.
40. Ventral aspect, segments xiii–xx
41. Dissection from dorsal aspect, segments i–xxi
42. Left anterior spermatheca, posterior aspect

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Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi, small, compact; spermatic funnels very large. Ovaries in xiii, consist of a number of moniliform processes. Vesiculae seminales in ix, xii, botryoidal; coelomic cavity of x, xi, is filled with a loose mass of sperms. Prostates in xvii, xix; wide tubular organs, compactly coiled. Penial chaetae absent. Copulatory muscles present. Spermathecae in viii, ix; large irregular sac, projecting laterally from a wide spermathecal duct; two slender pyriform diverticula, one lateral and one medial, open by narrow ducts into the spermathecal duct. (Fig. 42).

Nephridial vesicles absent.

Type Locality: Caswell Sound, Western Southland; under log; R. R. Forster, 11/4/49.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 9 specimens. Takahe Valley, Te Anau; P. C. Bull, 20/2/54; 1 specimen.

Eodrilus rossi n.sp. Figs. 43–45

Length 144 mm. Diameter 5·5 mm. 162 segments; i–v without secondary annulations, vi biannulate, posterior to vi all segments triannulate.

Colour pink with pale purplish clitellum.

Clitellum xiii–½xviii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=dd>ab; bc=2ab>aa.

Prostatic pores on xvii, xix, on prominent papillae, in line with chaeta b.

Male pores in seminal grooves on xviii, slightly lateral to chaeta b.

Female pores on xiv antero-lateral to chaeta a, close to anterior margin of segment.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta d on ii–v; in line with chaeta c posterior to v.

Pair of small, round tubercula pubertatis at 10/11, one on each side, in line with chaetal interval ab.

Septa vii/viii–xi/xii thickened and muscular.

Pharynx in i–iv, covered with small salivary glands. Short proventriculus in anterior part of v, opening into long gizzard in v. Oesophageal glands in xvi. Intestine commences in xviii.

Dorsal blood vessel paired posterior to vi/vii. Unpaired supra-intestinal vessel in x–xiii. Hearts connected to dorsal and supra-intestinal vessels, in x, xi, xii, xiii.

Testes in x, xi, consisting of a number of lobes. Ovaries in xiii, multilobate. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, long, coiled, tubular. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; elongate sac, oval in cross section, opening to the exterior through a short wide duct; two small diverticula, one anterior and one posterior, open into spermathecal duct. (Fig. 45).

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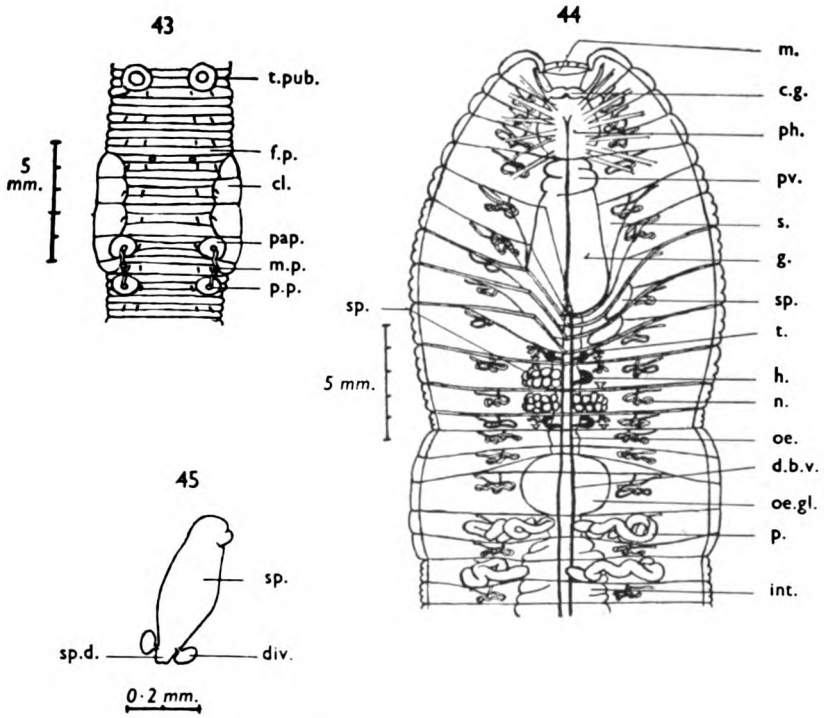

FIGS. 43–45. *Eodrilus rossi* n.sp.
43. Ventral aspect, segments xi–xx
44. Dissection from dorsal aspect, segments i–xx
45. Right posterior spermatheca, medial aspect

Nephridia without vesicles.

Type Locality: Ferguson's Bush, ½ mile N. of Kakopatahi R., between Ross and Harihari, Westland; topsoil, podocarp forest; K.E.L., 9/1/52.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 1 specimen.

Genus EUDINODRILOIDES n.g.

Chaetae 12 on each segment. Prostatic pores two pairs, on xvii, xix, ventro-lateral, on small rounded papillae. Seminal grooves present. Male pores in seminal grooves, on xviii. Female pores one pair, on xiv, ventro-lateral. Nephridiopores in a single lateral series on each side of the body. Septal thickening absent. Gizzard single, in v. Dorsal blood vessel paired for most of its length; four pairs of hearts, in x, xi, xii, xiii. Testes two pairs, in x, xi. Prostates two pairs, in xvii, xix, tubular. No penial chaetae nor copulatory muscles. Spermathecae two pairs, in viii, ix, each with two diverticula in same segment as sac. Nephridial vesicles present.

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Type species: *Eudinodriloides forsteri* n.sp.

Number of Species: One.

Eudinodriloides is established for a species which resembles the quadri-prostatic species of *Microscolex* but has twelve chaetae on each segment, while *Microscolex* has eight. In this respect it resembles *Dinodriloides,* but the latter genus is bi-prostatic. The gizzard of *Eudinodriloides* is weakly developed, like that of *Microscolex,* while the gizzard is well developed in *Dinodriloides,* as it is in *Rhododrilus.*

Only one species of the genus has so far been recorded. The following is a description of this species.

Eudinodriloides forsteri n.sp. Figs. 46–48

Length 36 mm. Diameter 2 mm. 94 segments.

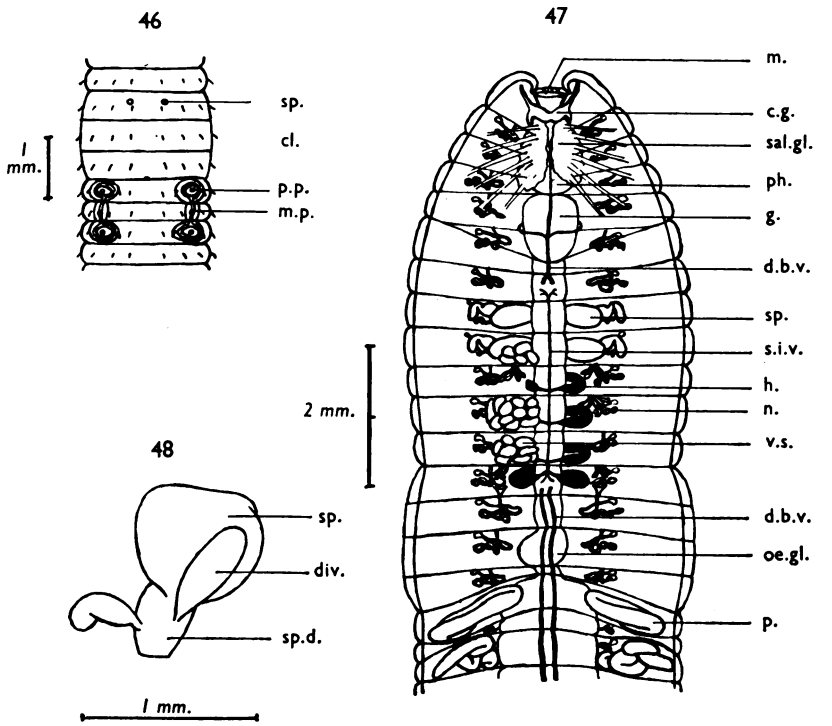
Colour yellow brown with darker brown clitellum (in alcohol).

Clitellum xiv–xvi, complete.

Prostomium tanylobous.

Chaetae 12/segment: aa=bc=cd=de=ef; ff>aa>ab.

Prostatic pores on small rounded papillae, situated in shallow pits, surrounded by a narrow ridge, on xvii, xix, in line with chaetal interval bc.



FIGS. 46–48. *Eudinodriloides forsteri* n.sp.
46. Ventral aspect, segments xiii–xx
47. Dissection from dorsal aspect, segments i–xix
48. Right anterior spermatheca, anterior aspect

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Male pores in seminal grooves on xviii, between chaetae b and c.
Female pores on xiv, anterior and slightly lateral to chaeta a.
Spermathecal pores at 7/8, 8/9, in line with chaeta c.
Nephridiopores in line with chaeta d.
No specially thickened septa.

Pharynx in i–iv, covered dorsally with salivary glands. Gizzard in v, small. Oesophageal glands in xv. Intestine commences in xvii. Dorsal blood vessel paired posterior to vi/vii. Unpaired supra-intestinal vessel extends through vii–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, consisting of cluster of tubular processes. Ovaries in xiii, similar in form to testes. Vesiculae seminales in ix, xi, xii, racemose; those of ix much smaller than those of xi, xii. Prostates in xvii, xix, compact, coiled, tubular. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; small sub-spherical sac with short thick duct; two small pyriform diverticula, one anterior and one lateral, open into spermathecal duct. (Fig. 48).

Nephridia with vesicles.

Type Locality: Seddonville, Nelson Province; leaf mould; G. Southgate, 6/11/50.

Type specimen in Canterbury Museum collection.

Localities:

South Island: Same data as type material; 5 specimens. Oparara; leaf mould; R. R. Forster, 20/1/50; 4 specimens. Woodpecker; leaf mould; R. R. Forster, 1/50; 2 specimens.

Genus Hoplochaetina Michaelsen

1920 *Hoplochaetina* Michaelsen, Mitt. zool. Mus. Hamb. 38:37.
1930 *Hoplochaetina,* Stephenson, Oligochaeta p. 845.
1952 *Hoplochaetina,* Lee, Trans. roy. Soc. N.Z. 79:566–7.

Chaetae numerous (more than 12) per segment. Clitellum (if present) developed over at least four segments between xiii and xix. Prostatic pores two pairs, on papillae, on xvii, xix. Seminal grooves present. Male pores on xviii in seminal grooves. Female pores on xiv, paired, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9, ventro-lateral. Some or all septa between gizzard and first intestinal segment strongly muscular and thickened. Gizzard single, strongly developed, in v or vi or vi–vii. Dorsal blood vessel paired, the two vessels fusing at the intersegmental septa in some species; four (in one species, five) pairs of hearts, the last pair in xiii. Testes two pairs, in x, xi, or one pair, in x, not in testis sacs. Prostates two pairs, in xvii, xix, each confined to a single segment; tubular. Penial chaetae lacking. Copulatory muscles present in large species. Spermathecae two pairs, in viii, ix, either with a single diverticulum or a large number of small diverticula. Micronephridia usually in small ventro-lateral tufts, sometimes in a band across the ventro-lateral and lateral aspects of the segments.

Type species: *Hoplochaetina rossii* (Benham)

Number of Species: Eight.

Distribution: New Zealand, five species from North Auckland, one

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from Mt. Egmont, one from D'Urville Id. and two from the south-west of the South Island. (Fig. 357).

This genus was established by Michaelsen (1920) and has, until now, been included in the subfamily Octochaetinae (see p. 32).

A species, *H. durvilleana,* was included by Benham (1919) in *Perieodrilus.* Since the species is micronephridial, while all the other species of *Perieodrilus* are meganephridial, and since *H. durvilleana* very closely resembles some species formerly assigned to *Hoplochaetina* (especially *H. rossii*), the species is placed in *Hoplochaetina.* Two new species, *H. spirilla* and *H. subtilis,* are described in this work, bringing the total number of species to eight.

KEY TO THE SPECIES OF HOPLOCHAETINA

a$_1$ Gizzard in v
  b$_1$ Oesophageal glands absent ..... **H. polycystis**
  b$_2$ Oesophageal glands present
    c$_1$ Spermatheca with one lateral diverticulum ..... **H. pallida**
    c$_2$ Spermatheca with numerous diverticula in a ring around duct
      d$_1$ Dorsal blood vessel paired throughout ..... **H. subtilis**
      d$_2$ Dorsal blood vessel paired, but two vessels fuse at each septum ..... **H. robusta**
a$_2$ Gizzard in vi or vi–vii
    e$_1$ Oesophageal glands absent
      f$_1$ Intestine commencing in xix; narrow, coiled in tight spiral ..... **H. spirilla**
      f$_2$ Intestine commencing in xviii, wide, not coiled ..... **H. rubra**
    e$_2$ Oesophageal glands present
      g$_1$ Dorsal blood vessel paired throughout ..... **H. durvilleana**
      g$_2$ Dorsal blood vessel paired, but two vessels fuse at each septum ..... **H. rossii**

The eight species of *Hoplochaetina* form a compact group, with small differences between individual species (see Table 4). Such differences as are apparent cannot be arranged in any sequence which is related to the geographical distribution of the species within the genus. Five species, *H. pallida, H. polycystis, H. robusta, H. spirilla* and *H. subtilis,* are confined to the North Auckland peninsula, while of the remaining three, *H. rubra* has been recorded only from Mt Egmont, *H. durvilleana* from D'Urville Island and *H. rossii* from the extreme south-west of the South Island. Such a distribution pattern is difficult to explain and when it is coupled with the very close anatomical and morphological relationships exhibited between species which are widely separated geographically a reasonable explanation is more difficult. The distribution pattern resembles that of *Dinodrilus,* but is fragmentary, except in the north of the North Island.

The number of pairs of vesiculae seminales might be taken as a significant character: *H. rubra, H. durvilleana* and *H. rossii* all have four pairs, in ix, x, xi, xii, while the North Auckland species have only one or two pairs. The gizzard in these three species is in vi or vi–vii, while all the North Auckland species have it in v, except *H. spirilla,* which has it in vi. The absence of calciferous glands would indicate a relationship between *H. rubra* and the North Auckland species *H. polycystis* and *H. spirilla,* but all other species have well developed calciferous glands. By selecting other individual characters it is possible to see relationships between any species and almost any other, regardless of their distribution. The only species which is sharply distinguished is

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TABLE 4. Hoplochaetina

——	*durvilleana*	*pallida*
Length	108 mm.	200 mm.
Diameter	6 mm.	10 mm.
Segments	117	157
Chaetae/segment	40–48	c. 40
Colour	brick red	pink
Clitellum	?	xiv–xvii
Extent of clitellum	–	xiv–xvi complete xvii dors and lat.
Prostomium	tanylobous	tanylobous
Prostatic papillae	very small	prominent, rounded
Position of prostatic pores ..	a/b	b
Position of male pores ..	?	b in seminal grooves
Position of female pores ..	?	close to ventral mid line
Position of spermathecal pores ..	7/8, 8/9 ?	7/8, 8/9 lateral to b
Septal thickening	ix/x–xiii/xiv	viii/ix–xiii/xiv
Proventriculus	?	absent
Gizzard	vi	v
Nature of gizzard	large	large
Oesophageal glands	x, xi, xii, xiii	xiv, xv
1st intestinal segment ..	xviii	xvii
Dorsal blood vessel	paired	paired
Hearts (pairs)	4	4
Origin of hearts	?	dorsal b. vv.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii sac	ix, xii racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	absent	present
Spermathecal diverticula:		
Number	1	1
Form	bifid	spheroidal, pustulate
Position	anterior	lateral
Arrangement of micronephridial tubules	ventro-lateral: tuft anteriorly, lateral band posteriorly	ventro-lateral tufts

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TABLE 4. Hoplochaetina—*continued*

polycystis	*robusta*	*rossii*	*rubra*
219 mm.	98 mm.	105–165 mm.	187 mm.
8 mm.	7·5 mm.	7 mm.	7·5 mm.
168	166	112	131
c. 70	c. 48	32–36	c. 48
pink	pink	brown	brick red
xiv–xix	?	xiii–xvii (xviii)	½xiii–½xvii
xiv–xvi complete	–	xiii–xv complete	complete
xvii–xix dors. and lat.		xvi–xvii dors. and lat.	
epilobous	epilobous	epilobous	tanylobous
prominent, domed	prominent, domed	prominent, domed	large, prominent
e	c	ventro-lateral	d
f/g in seminal grooves anterior to c	c/d in seminal grooves antero-medial	ventro-lat. in seminal grooves close to ventral mid line	d/e in seminal grooves close to ventral mid line
7/8, 8/9	7/8, 8/9	7/8, 8/9	7/8, 8/9
?	d	c/d	d
vi/vii–xiii/xiv	vi/vii–xii/xiii	viii/ix–xv/xvi	vii/viii–xiii/xiv
absent	absent	v–part vi	v
v	v	part vi–vii	vi
large	large	large	large
absent	xiv, xv	xv	absent
xx	xviii	xx	xviii
paired	paired but fusing at septa	paired but fusing at septa	paired
5	4	4	4
dorsal b. vv.	dorsal b. v.	dorsal b. v.	supra-intest. v.
x, xi	x, xi	x, xi	x, xi
ix, xii	xi	ix, x, xi, xii	ix, x, xi, xii
racemose	racemose	racemose	ix, x sac xi, xii botryoidal
xvii, xix	xvii, xix	xvii, xix	xvii, xix
absent	absent	absent	absent
present	absent	present	present
numerous slender, tubular surround duct ventro-lateral tufts	numerous globular surround duct ventral and ventro-lateral	numerous botryoidal groups surround duct lateral tufts	1 flat, pustulate anterior ventro-lateral tufts anteriorly, lateral band posteriorly

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TABLE 4. Hoplochaetina—*continued*

——	*spirilla*	*subtilis*
Length	81 mm.	92 mm.
Diameter	10·5 mm.	5 mm.
Segments	138	157
Chaetae/segment	c. 30	c. 48
Colour	pink	pink
Clitellum	xiv–xix	xiv–xvii
Extent of clitellum	xiv–xvi complete xvii–xix dors. and lat.	xiv–xvi complete xvii dors. and lat.
Prostomium	epilobous	prolobous
Prostatic papillae	prominent, conical	prominent, conical
Position of prostatic pores ..	b/c	a/b
Position of male pores ..	b/c in seminal grooves	e in seminal grooves
Position of female pores ..	anterior to a	anterior to a
Position of spermathecal pores ..	7/8, 8/9 b	7/8, 8/9 c
Septal thickening	vi/vii–xiv/xv	v/vi–xiii/xiv
Proventriculus	v	part v?
Gizzard	vi	v
Nature of gizzard	short, wide	large
Oesophageal glands	absent	viii, ix, x, xii, xiii, xiv
1st intestinal segment ..	xix	xvi
Dorsal blood vessel	paired	paired
Hearts (pairs)	4	4
Origin of hearts	supra-intest. v.	supra-intest. v.
Testes	x, xi	x
Vesiculae seminales	xi, xii sac	xi racemose
Prostates	xvii, xix	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	numerous	numerous
Form	globular	tubular
Position	surround duct	surround duct
Arrangement of micronephridial tubules	ventro-lateral tufts anteriorly, lateral band posteriorly	ventro-lateral–lateral

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H. spirilla, in which the intestine is coiled in a spiral. This is a most unusual character in earthworms, although it is not unknown in other genera.

Hoplochaetina durvilleana (Benham). Figs. 49–51

1919 *Perieodrilus durvilleanus* Benham, Trans. N.Z. Inst. 51:38–40.
1937 *Perieodrilus durvilleanus,* Pickford, Monograph p. 89.

The following diagnosis is taken from Benham (1919). It is based on a single immature specimen, and the species has not been collected since the original description was made.

Length 108 mm. Diameter 6 mm. 117 segments.

Colour brick red, with small white spot at base of each chaeta.

Clitellum not developed.

Prostomium tanylobous.

Chaetae 40–48/segment, not in pairs, but more or less equidistant.

Prostatic pores on very small papillae, on xvii, xix, lateral to chaeta a.

Seminal grooves and male pores not visible.

Female pores on xiv.

Spermathecal pores at 7/8, 8/9, ventro-lateral.

Septa ix/x to xiii/xiv thickened.

Gizzard in vi. Oesophageal glands in x, xi, xii, xiii. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, compact; those of ix and x long slender sacs, those of xi and xii shorter and wider. Prostates in xvii, xix, tubular. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; pointed ovate sac with short thick duct; bifid diverticulum consisting of two long pointed processes, one lateral and one medial, opens into anterior aspect of duct. (Fig. 49).

Nephridia: In ii–xiv there is a conspicuous tuft of minute looping tubules forming a "rosette" shape on each side; in ii–iv this tuft occurs on its own, from v–xiv tubules also extend outwards in a linear series from the "rosette" (Fig. 50); posterior to xiv the "rosette" is almost absent and only the linear series occurs (Fig. 51). Benham believed that the tubules open into a short duct, but was unable to trace it definitely. He assumed that it was present and placed the species in *Perieodrilus,* but this distribution of nephridia is quite common in *Hoplochaetina,* where it is recognised as a variation of the micronephridial condition, and is quite unlike the normal meganephridial condition found in other species of *Perieodrilus.* The close similarities which exist between *Hoplochaetina* and *Perieodrilus* have already been pointed out; their only distinguishing feature is the nephridial condition, and if the two genera are to be retained, the present species must go in *Hoplochaetina.*

Type Locality: D'Urville Island; W. B. Benham, 1919.

The type material of this species has not been located.

Localities: None.

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Hoplochaetina pallida Lee. Fig. 52

1952 *Hoplochaetina pallida* Lee, Trans. roy. Soc. N.Z. 79:568–9.

Length 200 mm. Diameter 10 mm. 157 segments. Colour pink with buff clitellum; body wall unpigmented.

Clitellum xiv–xvii; complete on xiv–xvi, dorsal and lateral on xvii.

Prostomium tanylobous.

Chaetae very numerous, more or less evenly spaced except for large median ventral gap.

Prostatic pores on prominent papillae on xvii, xix, in position of chaeta b.

Male pores on xviii, in seminal grooves, in position of chaeta b.

Female pores on xiv, very close to ventral mid line, appearing to the eye as one pore.

Spermathecal pores at 7/8, 8/9, slightly lateral to line of chaeta b.

Septa viii/ix–xiii/xiv thickened.

Gizzard in v. Oesophageal glands in xiv, xv. Intestine commences in xvii.

Dorsal blood vessel paired posterior to v/vi. Hearts from dorsal blood vessels in x, xi. xii, xiii.

Testes in x, xi, compact. Ovaries in xiii, compact. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, xix, tubular and coiled. Penial chaetae absent. Strong copulatory muscles present. Spermathecae in viii, ix; large spheroidal sac with narrow duct; large diverticulum with surface upraised in rounded pustules opens laterally into spermathecal duct. (Fig. 52).

Micronephridia in ventro-lateral clusters.

Type Locality: Tangowahine, North Auckland; subsoil, manuka scrub; K.E.L., 15/1/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 6 specimens. Pakotai, near Whangarei; subsoil, manuka scrub; K.E.L., 18/1/49; 2 specimens. Rehia, near Dargaville; subsoil, manuka scrub; K.E.L., 25/7/51; 5 specimens. Matakohe, near Dargaville; subsoil, manuka scrub; K.E.L., 25/7/51; 5 specimens

Tawhiti Rahi, Poor Knights Islands: Alluvium in small pocket on ridge side; J. S. Edwards, 27/12/52; 1 specimen. Leaf mould, coastal forest; J. S. Edwards, 27/12/52; 1 specimen.

Hoplochaetina polycystis Lee. Fig. 53

1952 *Hoplochaetina polycystis* Lee, Trans. roy. Soc. N.Z 79:569–70.

Length 219 mm. Diameter 8 mm. 168 segments, all except i triannulate.

Colour pink with darker pink clitellum; body wall unpigmented.

Clitellum xiv–xix; complete on xiv–xvi, dorsal and lateral on xvii–xix.

Prostomium epilobous.

Chaetae c.70/segment, closely spaced except for wide mid ventral gap.

Prostatic pores on prominent dome-shaped papillae, on xvii, xix, ventro-lateral.

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Male pores in seminal grooves on xviii, slightly lateral to line joining prostatic pores.

Female pores on xiv, anterior to chaeta c.

Spermathecal pores at 7/8, 8/9, ventro-lateral.

Septa vi/vii–xiii/xiv thickened. Septa absent anterior to iv/v.

Gizzard in v. Oesophageal glands absent. Intestine commences in xx.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in ix, x, xi, xii, xiii; those of ix much smaller than those of x, xi, xii, xiii. Testes in x, xi, compact. Ovaries in xiii, compact. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, xix, tubular and convoluted. Penial chaetae absent. Strong copulatory muscles present. Spermathecae in viii, ix; small ovoidal sac, flattened dorso-ventrally, with narrow duct; large number of small diverticula open into anterior and lateral aspects of spermathecal duct. (Fig. 53).

Micronephridia in small ventro-lateral tufts on each side of segments.

Type Locality: Near summit of Mangamuku Ra., south of Kaitaia; subsoil, podocarp-broadleaved forest; K.E.L., 23/3/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Victoria Valley, near Kaitaia; topsoil, manuka scrub; K.E.L., 23/3/49; 3 specimens.

Hoplochaetina robusta Lee. Fig. 54

1952 *Hoplochaetina robusta* Lee, Trans. roy. Soc. N.Z. 79:567–8.

Length 98 mm. Diameter 7·5 mm. 166 segments.

Colour pink; body wall unpigmented.

Clitellum not developed.

Prostomium epilobous.

Chaetae c.48/segment, closely spaced except for large ventral gap.

Prostatic pores on prominent dome-like papillae on xvii, xix, in line with chaeta c.

Male pores in seminal grooves on xviii, slightly lateral to line of prostatic pores.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta d.

Septa vi/vii–xii/xiii thickened.

Gizzard in v. Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel paired posterior to v/vi, but the two vessels fuse at each septum. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi, compact. Ovaries in xiii, compact. Vesiculae seminales in xi, racemose. Prostates in xvii, xix, tubular and convoluted. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; globular sac with short thick duct; complete ring of small round diverticula surrounding spermathecal duct. (Fig. 54).

Very small nephridial tubules in band across ventral and ventro-lateral aspects of segments.

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Type Locality: Mangakahia Valley, near Whangarei; topsoil, broad-leaved forest; K.E.L. 18/1/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen.

Hoplochaetina rossii (Benham). Fig. 55

1903 *Plagiochaeta rossii* Benham, Trans. N.Z. Inst. 35: 284–5.
1904 *Plagiochaeta rossi,* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 229.
1909 *Hoplochaetella rossii,* Michaelsen, Mem. Indian Mus. 1 (3) :202.
1910 *Hoplochaetella Rossii,* Michaelsen, Mitt zool. Mus. Hamb. 27:110.
1913 *Hoplochaetella rossi,* Benham and Cameron, Trans. N.Z. Inst. 45:192.
1920 *Hoplochaetina rossi,* Michaelsen, Mitt. zool. Mus. Hamb. 38:37.
1952 *Hoplochaetina rossii,* Lee, Trans. roy. Soc. N.Z. 79:567.

Length 105–165 mm. Diameter 7 mm. 112 segments.

Colour greyish brown anteriorly, purplish brown posterior to clitellum, with darker brown median dorsal stripe; chaetae arising from small light spots.

Clitellum xiii–xvii (or xviii); complete on xiii–xv, dorsal and lateral on xvi–xvii.

Prostomium epilobous.

Chaetae 32–36/segment, more or less equidistant except for larger dorsal and ventral gaps.

Prostatic pores on prominent papillae on xvii, xix, ventro-lateral.

Male pores on xviii in very poorly defined seminal grooves, slightly lateral to line of prostatic pores.

Female pores on xiv, close to ventral mid line anterior to the chaetae.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval cd.

Septa viii/ix–xv/xvi thickened.

Proventriculus in v–part vi.

Gizzard in part vi–vii. Oesophageal glands in xv. Intestine commences in xx.

Dorsal blood vessel paired posterior to iv/v, but the two vessels fuse at each intersegmental septum. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii, very large. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xvii, xix, tubular and coiled. Penial chaetae absent. Strong copulatory muscles present. Spermathecae in viii, ix; large ovoidal sac with short thick duct; groups of small botryoidal diverticula around duct. (Fig. 55).

Small tufts of micronephridia in series on lateral aspects of peritoneum.

Type Locality: Lake Te Anau, in forest on shore; W. B. Benham, 1903.

Type material in Otago Museum (No. A.02.131); 1 complete specimen and 2 fragments, all in good condition.

Localities:

South Island: Upper Stillwater R., Caswell Sound; B. Wisely, 3/49; 1 specimen. Caswell Sound; under log; R. R. Forster, 12/4/49; 1 specimen.

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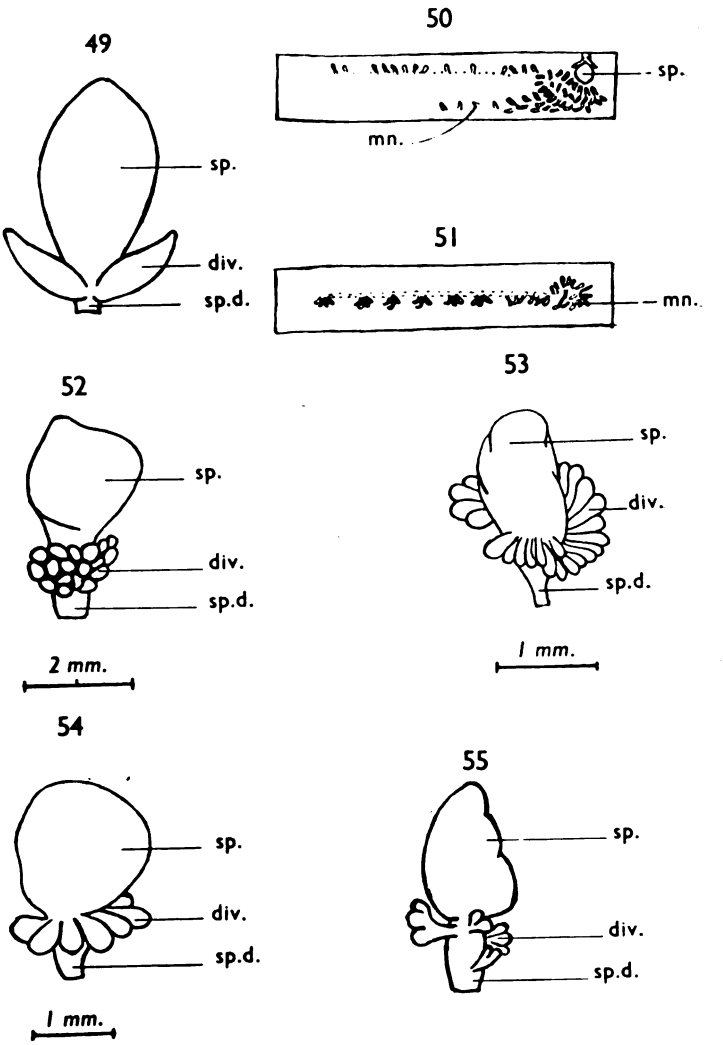

FIGS. 49–51. *Hoplochaetina durvillcana*
49. Spermatheca
50. Nephridial arrangement, left side, segment viii
51. Nephridial arrangement, left side, segment xv
(Drawings after Benham, 1919)

FIG. 52. *Hoplochaetina pallida*. Right anterior spermatheca, posterior aspect

FIG. 53. *Hoplochaetina polycystis*. Right anterior spermatheca, lateral aspect

FIG. 54. *Hoplochaetina robusta*. Right anterior spermatheca, lateral aspect

FIG. 55. *Hoplochaetina rossii*. Spermatheca. (After Benham, 1903b)

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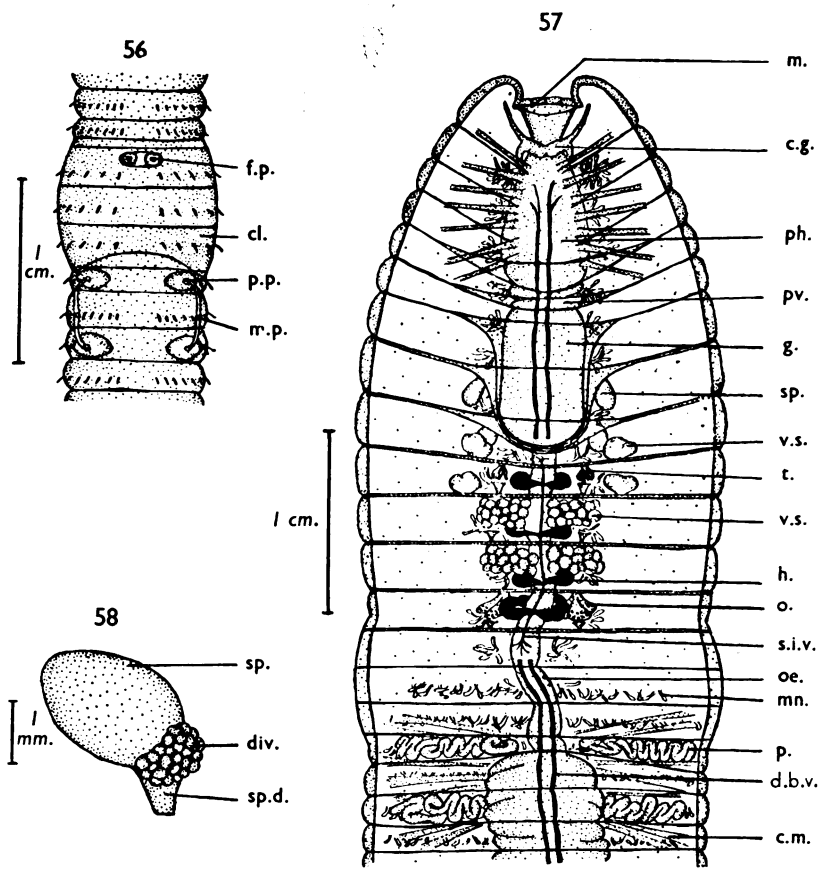

FIGS. 56–58. *Hoplochaetina rubra* n.sp.
56. Ventral aspect, segments xii–xx
57. Dissection from dorsal aspect, segments i–xx.
58. Right anterior spermatheca, lateral aspect

Hoplochaetina rubra n.sp. Figs. 56–58

Length 187 mm. Diameter 7·5 mm. 131 segments.

Colour brick red dorsally, pale ventrally anterior to clitellum; posterior to clitellum the brick red colour fades gradually to reddish brown and dorsal and ventral aspects are the same colour; a narrow dark red streak extends along the dorsal mid line. Clitellum purplish.

Clitellum part xiii–part xvii, complete.

Prostomium tanylobous.

Chaetae about 48/segment; evenly spaced except for dorsal and ventral gaps; chaetae on clitellar segments more widely spaced than on other segments.

Prostatic pores on very large prominent papillae, on xvii, xix, ventrolateral.

Male pores in seminal grooves on xviii, between chaetae d and e, slightly lateral to line of prostatic pores.

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Female pores on xiv, very close to ventral mid line, anterior to the chaetae.

Spermathecal pores at 7/8, 8/9, in line with chaeta d.

Septa vii/viii–xiii/xiv thickened.

Pharynx in i–iv, elongate. Short, wide, thin-walled proventriculus in v. Gizzard in vi, long. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in ix–xiv. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, consisting of a number of hair-like processes. Ovaries in xiii, thin folded lamina with individual ova projecting and arranged in lines parallel to the free edge of the lamina. Vesiculae seminales in ix, x, xi, xii; those of ix, x small, sac-like; those of xi, xii botryoidal. Prostates in xvii, xix, tubular, extremely convoluted. Penial chaetae absent. Strong copulatory muscles present. Spermathecae in viii, ix; rounded, almost spherical, sac with wide muscular duct; single diverticulum, with surface upraised in small pustules, surrounds anterior and lateral aspects of spermathecal duct and opens into anterior aspect of duct. (Fig. 58).

Micronephridia arranged in ventro-lateral clusters in ii–xiv; posterior to xiv arranged in a narrow band across lateral aspects of segments.

Type Locality: Eastern slopes of Mt. Egmont, 3,500–4,000 ft.; under rocks; J. S. Edwards, 11/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Plateau, Mt. Egmont, 4,000 ft.; soil surface; J. S. Edwards, 11/51; 1 specimen. Manganui, Mt. Egmont; under logs; J. S. Edwards, 11/51; 1 specimen.

Remarks: This species bears a striking physical resemblance to *Perionyx egmonti,* which is found in the same locality.

Hoplochaetina spirilla n.sp. Figs. 59–62

Length 81 mm. Diameter 10·5 mm. 138 segments.

Colour pink with red clitellum.

Clitellum xiv–xix; complete on xiv–xvi, dorsal and lateral on xvii–xix.

Prostomium epilobous.

Chaetae c.30/segment; anterior to clitellum fairly regularly spaced except for wider ventral gap; posterior to clitellum irregularly spaced except for regular ventral gap.

Prostatic pores on prominent, white, conical papillae, on xvii, xix, between chaetae b and c.

Male pores in seminal grooves on xviii, between chaetae b and c.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa vi/vii–xiv/xv slightly thickened.

Small globular pharynx in i–iv. Proventriculus in v, wide, thin walled. Gizzard in vi, short, wide. Oesophageal glands absent. Limits of oesophagus and intestine difficult to determine. Posterior to gizzard alimentary canal is a straight tube to xviii; in xix the tube is slightly coiled,

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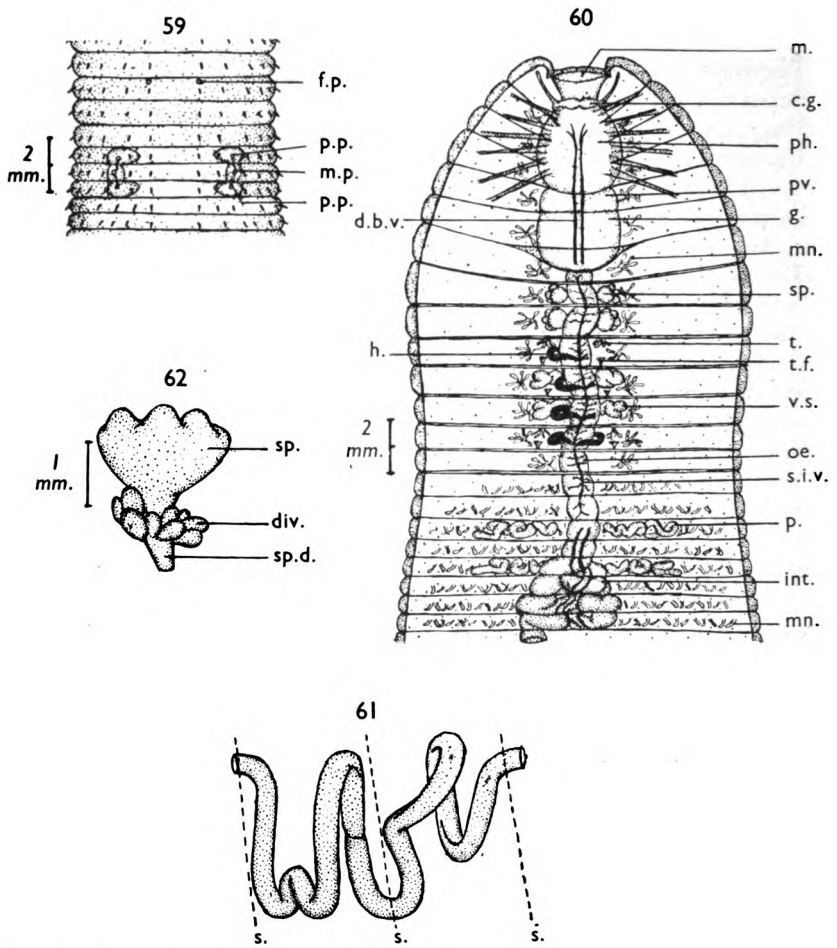

FIGS. 59–62. *Hoplochaetina spirilla* n.sp.
59. Ventral aspect, segments xiii–xx
60. Dissection from dorsal aspect, segments i–xxii
61. Diagrammatic representation of intestinal spiralling, right dorso-lateral aspect
62. Left anterior spermatheca, anterior aspect

in xx the coiling is more marked, and in xxi the tube assumes a fairly complex spiral coiling, which it maintains back to segment cxxv, where it again becomes a straight tube, leading directly to the anus. The coiled tube might be regarded as the intestine, commencing in xix, and the straight tube as the oesophagus, terminating in xviii. Spiralling of the intestine is most uncommon in earthworms. It has been recorded by Benham (1891) in *Plagiochaeta punctata* (=*Plagiochaeta sylvestris*) and by Fletcher (1886) in *Didymogaster sylvaticus*. Coiling of the intestine is common in many groups of animals as a method of increasing the surface area of intestinal epithelium in relation to the size of the body. In most species of earthworms there is

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a typhlosole, which gives an increased surface area of intestinal epithelium, but coiling of the intestine is more effective. The nature of the coiling of the intestine is illustrated diagrammatically in Fig. 61.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in vii–xvi. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, consisting of clusters of short, thick, thread-like structures. Ovaries in xiii, consisting of clusters of thread-like structures, longer and thinner than those of testes. Vesiculae seminales in xi, xii, sac-like, lying against ventro-lateral aspects of oesophagus. Prostates in xvii, xix, convoluted, tubular, small in size. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; irregularly shaped, large sac, with long narrow duct; a number of small diverticula (about 15) are clustered around the distal portion of the duct. (Fig. 62).

Micronephridia of ii–xiv in compact ventro-lateral clusters; posterior to xiv the micronephridia are in a band across the ventro-lateral and lateral aspects of the segments.

Type Locality: Leigh, SW of Whangarei; subsoil, scrub; K.E.L., 26/7/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Tauraroa, near Whangarei; subsoil, manuka scrub; K.E.L., 25/7/51; 1 specimen. White Cone, near Whangarei; subsoil, podocarp-broadleaved forest; K.E.L., 25/7/51; 6 specimens. Ruatangata West, near Whangarei; topsoil, podocarp forest; K.E.L., 26/7/51; 4 specimens. Warkworth; topsoil, manuka scrub; K.E.L., 28/7/51; 2 specimens.

Remarks: This species is readily recognisable in the field by its short, very thick body, extreme inactivity, and the bright yellow colour of its coelomic fluid, which it exudes when irritated.

Hoplochaetina subtilis n.sp. Figs. 63–65

Length 92 mm. Diameter 5 mm. 157 segments; i–v without annulations, vi–x biannulate, posterior to x triannulate except for clitellar segments which have no segmental nor secondary annulations.

Colour pink with brownish yellow clitellum.

Clitellum xiv–xvii; complete on xiv–xvi; dorsal and lateral on xvii.

Prostomium prolobous.

Chaetae c.48/segment; almost evenly spaced except for wide median dorsal and ventral gaps.

Prostatic pores on prominent, pointed papillae, on xvii, xix, lateral to chaeta a.

Male pores in seminal grooves on xviii, lateral to line of prostatic pores, about in position of chaeta e.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, anterior to chaeta c.

Septa v/vi to xiii/xiv thickened.

Pharynx in i–iv. Gizzard in v; anteriorly it is thin walled and may be regarded as a proventriculus, posteriorly it is thick walled and muscular.

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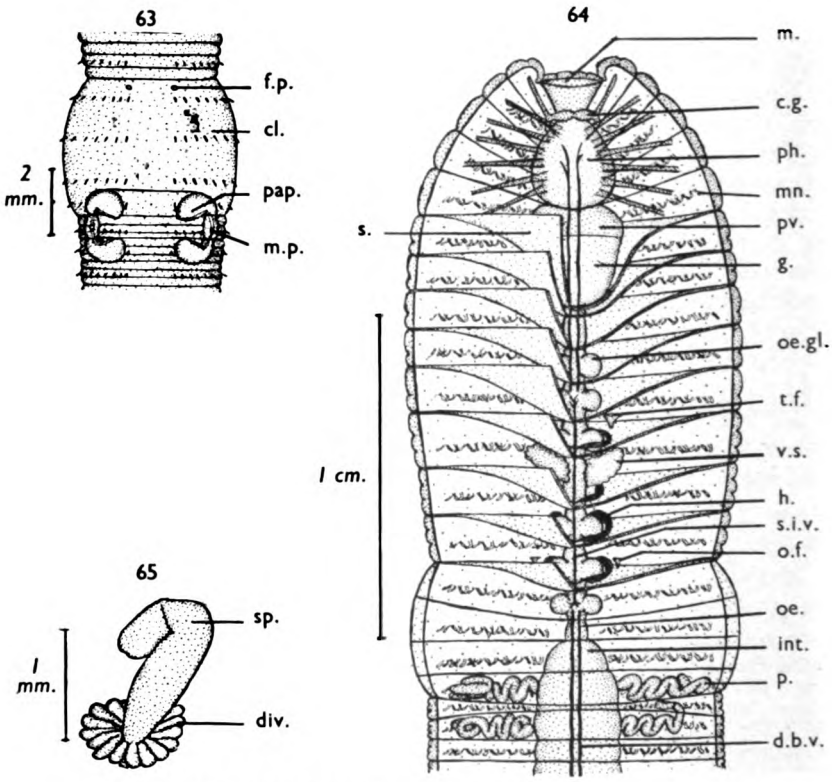

FIGS. 63–65. *Hoplochaetina subtilis* n.sp.
63. Ventral aspect, segments xiii–xx
64. Dissection from dorsal aspect, segments i–xx
65. Left anterior spermatheca, anterior aspect

Oesophageal glands in viii, ix, x, xii, xiii, xiv. Intestine commences in xvi.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in ix–xiv. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, small, compact, with very large funnels. Ovaries in xiii, small, compact, with small funnels. Vesiculae seminales in xi, racemose. Prostates in xvii, xix, tubular, convoluted and coiled distally. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; long tubular sac, curved in "J"-shape; large number of very small diverticula forming almost complete ring around the organ at the junction of sac and duct. (Fig. 65).

Micronephridia in a narrow band across ventro-lateral and lateral aspects of segments.

Type Locality: Tinopai, North Auckland; topsoil, manuka scrub; K.E.L. 25/7/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 3 specimens.
Hen and Chickens Is.: Big Chick Id.; topsoil, forest; M. Esson, Sept. 1955; 3 specimens.

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Genus LEUCODRILUS Lee

1952 *Leucodrilus* Lee, Trans. roy. Soc. N.Z. 79:570.

Chaetae eight per segment. Clitellum developed over four to six segments between xiii and xix. Prostatic pores one pair, on papillae, on xvii. Male pores on extreme anterior margin of xviii, directly behind prostatic pores. Female pores on xiv, paired, ventro-lateral. Spermathecal pores one to four pairs, anterior to 9/10. Septa vii/viii to xii/xiii or xiii/xiv strongly muscular and thickened. Proventriculus in v or part v. Gizzard strongly developed, in v or part v–vi. Intestine commences in xvii. Dorsal blood vessel unpaired. Four pairs of hearts, the last pair in xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates one pair, with ducts opening to the exterior in xvii; tubular. Penial chaetae present. Copulatory muscles absent. Spermathecae one to four pairs, the last in viii or ix; each with one diverticulum in the same segment. Micronephridia in ventro-lateral tufts.

Type species: *Leucodrilus digitocystis* Lee.

Number of Species: Three.

Distribution: New Zealand, confined to eastern districts of the North Island. (Fig. 360).

The genus was originally placed in the subfamily Octochaetinae because it is micronephridial (see p. 33). One new species, *L. robustus*, is described in this work, bringing the total number of species to three.

KEY TO THE SPECIES OF LEUCODRILUS

a_1 One pair of spermathecae
  b_1 Spermathecae in viii; oesophageal glands one pair, in xii ..... **L. fuscus**
  b_2 Spermathecae in ix; oesophageal glands absent ..... **L. digitocystis**
a_2 Four pairs of spermathecae; oesophageal glands three pairs, in xiii, xiv, xv ..... **L. robustus**

The three species of *Leucodrilus* are confined to the eastern portion of the North Island of New Zealand, from Hawke's Bay to East Cape. The most common earthworms in this region belong to the genus *Rhododrilus*, from which *Leucodrilus* has probably been derived. The writer previously supposed the genus to be allied to *Octochaetus* (Lee, 1952b), but is no longer of that opinion. The concentration of the micronephridial tubules in ventro-lateral tufts is a characteristic that closely allies the genus to *Rhododrilus*, since one species of the latter genus (*R. disparatus*), which is found within the area occupied by *Leucodrilus*, has a small ventro-lateral tuft of micronephridia associated with each meganephridium in the first twenty segments. The presence of penial chaetae in all species of *Leucodrilus* also indicates a relationship to *Rhododrilus* rather than *Octochaetus*, since a number of species of *Rhododrilus* have penial chaetae, while in *Octochaetus* there is only one rather doubtful record of the presence of penial chaetae (in *O. antarcticus*). *Leucodrilus*, together with *R. disparatus*, might be regarded as an aberrant group of species within the genus *Rhododrilus*, but I have retained a generic distinction.

The three species of *Leucodrilus* are distinguished from one another only by a number of small anatomical differences, such as the number and position of the spermathecae and oesophageal glands (see Table 5).

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TABLE 5. Leucodrilus

——	*digitocystis*	*fuscus*	*robustus*
Length	97–180 mm.	296 mm.	625 mm.
Diameter	6–12 mm.	10·5 mm.	7 mm.
Segments	150–200	264	c. 550
Colour	pale pink	sienna brown	brown
Clitellum	½xiii–xvii	xiii–xvii	½xiii–½xix
Extent of clitellum	xiv-xvii complete ½xiii dors. and lat.	dorsal and lateral	complete
Prostomium	epilobous	epilobous	prolobous
Prostatic papillae	prominent, rounded	prominent, conical	small, rounded
Position of prostatic pores ..	a/b	a/b	a/b
Position of male pores ..	a/b, extreme ant. margin of xviii	a/b, extreme ant. margin of xviii	a/b, extreme ant. margin of xviii
Position of female pores ..	anterior to a	anterior to a	anterior to a
Position of spermathecal pores ..	8/9 b	7/8 a	near ant. margins of vi, vii, viii, ix
Septal thickening	vii/viii–xiii/xiv	vii/viii–xii/xiii	vii/viii–xii/xiii
Proventriculus	v	v	part v
Gizzard	vi	vi	part v–vi
Nature of gizzard	large, strong	long, thick walled	large, strong
Oesophageal glands	absent	xii	xiii, xiv, xv
1st intestinal segment ..	xvii	xvii	xvii
Dorsal blood vessel	unpaired	unpaired	unpaired
Hearts (pairs)	4	4	4
Last heart	xiii	xiii	xiii
Origin of hearts	dorsal b.v.	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi	x, xi
Vesiculae seminales	xi, xii botryoidal	xi, xii racemose	xi, xii racemose
Prostates	xvii–xxi (xxiii)	xvii–xxi	xvii–xxi
Penial chaetae	present	present	present
Copulatory muscles	absent	absent	absent
Spermathecal diverticula:			
Number	1	1	1
Form	long, tubular	rosette shaped	slender, pyriform
Position	anterior	anterior	posterior
Arrangement of micronephridia	ventro-lateral tufts	ventro-lateral tufts	ventro-lateral tufts

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Leucodrilus digitocystis Lee. Figs. 66–68

1952 *Leucodrilus digitocystis* Lee, Trans. roy. Soc. N.Z. 79:570–2.

Length 97–180 mm. Diameter 6–12 mm. 150–200 segments; i–v without secondary annulations, vi biannulate, posterior to vi triannulate.

Colour pale pink dorsally, unpigmented ventrally, with pink clitellum.

Clitellum ½xiii–xvii; complete on xiv–xvii, dorsal only on ½xiii.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa=bc; dd>aa>ab.

Prostatic pores on prominent white papillae on xvii in line with chaetal interval ab.

Male pores on anterior margin of xviii, in line with prostatic pores.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

Septa vii/viii–xiii/xiv thickened.

Proventriculus in v, wide, thin walled. Gizzard in vi. Oesophageal glands absent. Intestine commences in xvii.

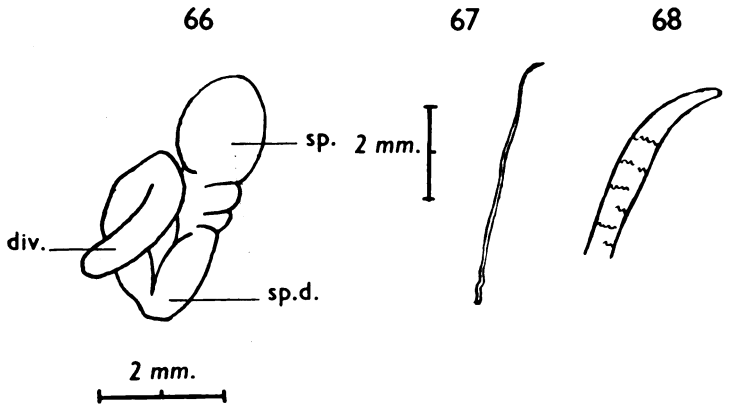
Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxi or xxiii; tubular, coiled distally. Penial chaetae in elongate sacs extending through xvii–xxi; elongate, slightly undulating shaft, sharply curved near tip and pointed (Figs. 67, 68). Spermathecae in ix; large thin-walled ovoidal sac with wide muscular duct; long, slender, tubular diverticulum, folded back on itself, opens into spermathecal duct. (Fig. 66).

Small cluster of micronephridia on each side of ventral nerve cord in each segment.

Type Locality: Near Waimarama, Hawke's Bay; topsoil, coastal forest; K.E.L., 4/7/49.

Type specimen in Soil Bureau collection.



FIGS. 66–68. *Leucodrilus digitocystis*
66. Right spermatheca, medial aspect
67. Penial chaeta
68. Tip of penial chaeta

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Localities:

North Island: Same data as type material; 9 specimens. Same data as type material; K.E.L., 30/11/49; 5 specimens. Waimarama Ra., Hawke's Bay; topsoil, podocarp forest; K.E.L., 4/7/49; 11 specimens. Same data; K.E.L., 30/11/49; 9 specimens. Wakarara, western Hawke's Bay; topsoil, podocarp forest; K.E.L., 6/7/49; 3 specimens. Same data; K.E.L., 1/12/49; 5 specimens. Raukawa Valley, Hawke's Bay; topsoil, podocarp forest; K.E.L., 6/7/49; 2 specimens. Same data; K.E.L, 1/12/49; 1 specimen. Gray's Bush, Gisborne; topsoil, podocarp forest; K.E.L., 23/11/49; 6 specimens. 3 miles S. of Tolaga Bay; topsoil, forest; K.E.L., 23/11/49; 5 specimens. 11 miles N. of Tolaga Bay; topsoil, coastal forest; K.E.L., 9/1/51; 4 specimens. Te Puia; topsoil, coastal forest; K.E.L., 10/1/51; 3 specimens. Ruatoria; topsoil, coastal forest; K.E.L., 10/1/51; 7 specimens. 10 miles S. of Te Araroa; topsoil, coastal forest; K.E.L., 10/1/51; 3 specimens. 3 miles N.W. of Te Araroa; topsoil, coastal forest; K.E.L., 10/1/51; 2 specimens. 7 miles E. of Te Kaha; topsoil, coastal forest; K.E.L., 11/1/51; 6 specimens. Omaio, near Te Kaha; topsoil, coastal forest; K.E.L., 12/1/51; 5 specimens. Omaio; topsoil, small grassy flat overlooking sea; K.E.L., 12/1/51; 4 specimens. Motu R., near Opotiki; topsoil, coastal scrub; K.E.L., 12/1/51; 10 specimens. Torere, near Opotiki; topsoil, coastal scrub; K.E.L., 12/1/51; 1 specimen. Waioeka Gorge, 10 miles S. of Opotiki; topsoil, coastal forest; K.E.L., 12/1/51; 2 specimens. Waioeka Gorge, 18 miles S. of Opotiki; topsoil, podocarp forest; K.E.L., 13/1/51; 4 specimens. Waioeka Gorge, 27 miles S. of Opotiki; topsoil, podocarp forest; K.E.L., 13/1/51; 5 specimens. Waioeka Gorge, 35 miles S. of Opotiki; topsoil, podocarp forest; K.E.L., 13/1/51; 4 specimens.

Leucodrilus fuscus Lee. Figs. 69–71

1952 *Leucodrilus fuscus* Lee, Trans. roy. Soc. N.Z. 79:572–3.

Length 296 mm. Diameter 10·5 mm. 264 segments; ii–v biannulate, posterior to v triannulate.

Colour pale sienna brown dorsally, pale silvery white ventrally, with prominent brown clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa>dd>bc>ab.

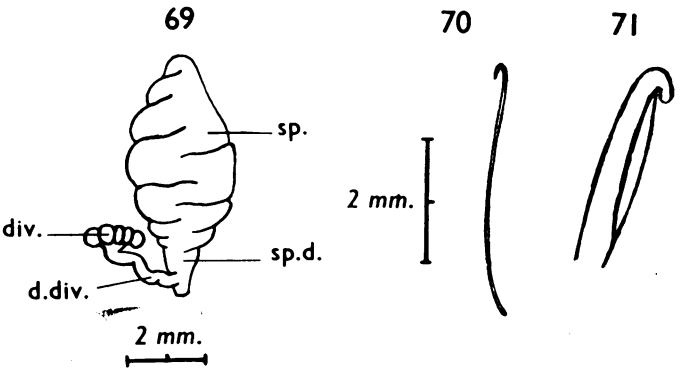
Prostatic pores on prominent conical papillae on xvii, in line with chaetal interval ab.

Male pores not visible externally.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, in line with chaeta a, with prominent lips.

Septa vii/viii–xii/xiii thickened.



FIGS. 69–71. *Leucodrilus fuscus*
69. Right spermatheca, anterior aspect
70. Penial chaeta
71. Tip of penial chaeta

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Proventriculus in v, short and thin walled. Gizzard in vi, long and thick walled. Oesophageal glands in xii. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii, moniliform.

Testes in x, xi, very small; the vasa deferentia are parallel on each side back to xvii, where they fuse, the combined duct then passes into xviii and opens to the exterior immediately behind septum xvii/xviii, in line with the opening of the corresponding prostatic duct. Ovaries in xiii, small and compact. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xxi, convoluted, tubular. Penial chaetae in short sacs in xvii; stout, slightly curved shaft with sharply recurved, flattened, hook-like tip. (Figs. 70, 71) Spermathecae in viii; large flattened oval sac with wide duct; rosette-shaped diverticulum lateral to sac, opening by long narrow duct into spermathecal duct. (Fig. 69).

Micronephridia arranged in small cluster close to ventral nerve cord on each side of segments.

Type Locality: 20 miles N. of Wairoa, northern Hawke's Bay; topsoil, coastal forest; K.E.L., 25/11/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 6 specimens.

Leucodrilus robustus n.sp. Figs. 72–76

Length 625 mm. Diameter 7 mm. About 550 segments; anterior to clitellum segments are biannulate (except i), clitellar segments have no secondary annulations, posterior to clitellum segments are quadriannulate.

Colour brown with pale brown clitellum.

Clitellum ½xiii–½xix, complete.

Prostomium prolobous.

Chaetae 8/segment: aa=bc=cd ≫ ab; dd ≫ aa.

Prostatic pores on small papillae on xvii, in line with chaetal interval ab.

Male pores not visible externally.

Females pores on xiv; transverse slit-like apertures, anterior to chaeta a.

Spermathecal pores not visible externally.

Septa vii/viii–xii/xiii greatly thickened, xiii/xiv slightly thickened.

Pharynx in i–iv, large, with strong extrinsic muscles, and covered dorsally and laterally by masses of salivary gland tissue. Proventriculus in anterior portion of v, thin walled. Gizzard in remainder of v and all of vi. Oesophageal glands in xiii, xiv, xv, those of xiii and xiv much larger than those of xv. Intestine commences in xvii.

Dorsal blood vessel unpaired. Unpaired supra-intenstinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi; combined vas deferens of each side opens to exterior at extreme anterior margin of xviii, in line with corresponding prostatic pore. Ovaries in xiii. Vesiculae seminales in xi, xii racemose.

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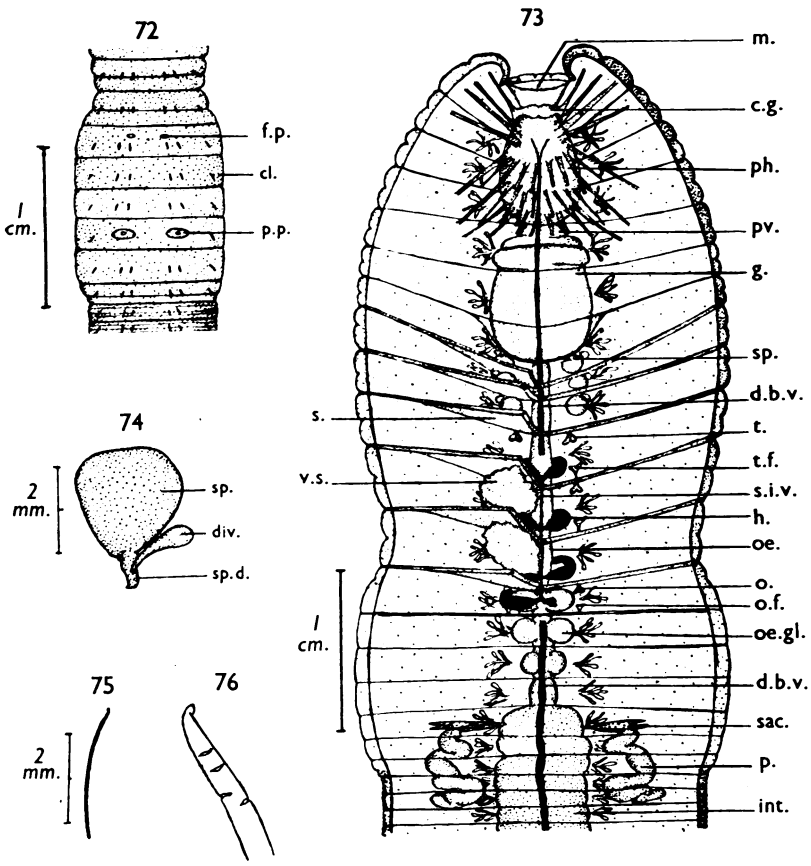

FIGS. 72–76. *Leucodrilus robustus* n.sp.
72. Ventral aspect, segments xii–xx
73. Dissection from dorsal aspect, segments i–xxii
74. Left spermatheca of segment viii, posterior aspect
75. Penial chaeta
76. Tip of penial chaeta

Prostates in xvii–xxi, tubular, convoluted. Penial chatae in sacs in xvii; long slender, gently curved, with slightly recurved rounded tip (Figs. 75, 76). Spermathecae in vi, vii, viii, ix; large spheroidal sac opening by narrow muscular duct to exterior close to anterior margin of segment; small, slender, pyriform diverticulum lies lateral to sac and opens into the posterior aspect of the spermathecal duct. (Fig. 74).

Micronephridia in small compact clusters beside ventral nerve cord in each segment.

Type Locality: 3 miles N.W. of Hicks Bay; subsoil, coastal forest; K.E.L., 11/1/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 4 specimens. Patoka, near Hicks Bay; subsoil, forest; K.E.L., 11/1/51; 1 specimen.

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Genus MICROSCOLEX Rosa, emend. Pickford

1887 *Microscolex* Rosa, Boll. Mus. Zool. Anat. comp. Torino 3 (39) :1.
1887 *Eudrilus?*, Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 2 :378.
1887 *Photodrilus*, Giard, C. R. Acad. Sci., Paris, 105 :872.
1889 Subgen. *Allurus* (part), Vaillant, Hist. nat. Annel. 3 (1) :115.
1893 *Deltania*, Eisen, Zoe, 4 :250.
1894 *Deltania* + *Rhododrilus*, (part), Eisen, Mem. Calif. Acad. Sci. 2 (3) :22.
1895 *Pontodrilus* (part), Beddard, Monograph p. 468.
1900 *Microscolex* (part), Michaelsen, Tierreich 10 :139.
1907 *Microscolex* (part) + *Eodrilus* (part), Michaelsen, Die Fauna Südwest-Aust. 1 (2) :146.
1930 *Microscolex* (part), Stephenson, Oligochaeta p. 824.
1937 *Microscolex*, Pickford, Monograph p. 424.

Chaetae eight on each segment. Prostatic pores two pairs, on xvii, xix, or one pair on xvii. Male pores one pair, on xvii or xviii, rarely fused with the anterior prostatic pores. Spermathecal pores two pairs at 7/8, 8/9, or one pair at 7/8 or 8/9, rarely wanting. Nephridiopores in a single series on each side. Gizzard reduced or rudimentary. Testes two pairs, in x, xi, or one pair in x, with or without rudimentary funnels in xi; not in testis sacs. Nephridia with terminal vesicles of a simple ovoidal or tubular form.

Type species: *Microscolex phosphoreus* (Dugès) 1837

Number of Species: Nineteen, including five recorded from the New Zealand region.

Distribution: Southern South America, Falkland Is., South Georgia, Kerguelen, Marion Id., South Africa, Campbell Id., Auckland and Antipodes Is., Macquarie Id., Darien(?).

Microscolex was one of the first Megascolecid genera established. It has been variously defined by Michaelsen, Stephenson and other workers. The definition used in this work is that of Pickford (1937). Pickford's clarification of the position of the genera *Microscolex*, *Acanthodrilus* and *Eodrilus* has been discussed in an earlier section.

KEY TO THE NEW ZEALAND SPECIES OF MICROSCOLEX

a$_1$ One pair of prostatic pores, combined with male pores, on xvii
  b$_1$ Spermathecae absent ..... **M. dubius**
  b$_2$ One pair of spermathecae, in viii ..... **M. phosphoreus**
a$_2$ Two pairs of prostatic pores, a pair on xvii and a pair on xix; male pores in seminal grooves on xviii
  c$_1$ Dorsal blood vessel unpaired throughout its length
    d$_1$ Intestine commencing in xv; spermathecae in viii, ix, each with two ovoidal diverticula ..... **M. campbellianus**
    d$_2$ Intestine commencing in xviii; spermathecae in viii, ix, each with two tubular diverticula ..... **M. aucklandicus**
  c$_2$ Dorsal blood vessel paired posterior to x/xi ..... **M. macquariensis**

Two species, *M. dubius* and *M. phosphoreus*, were recorded by Smith (1893) from the mainland of New Zealand. They have not been recorded again. Both species are peregrine and have achieved a world-wide distribution. They are biprostatic and in this respect differ from the remaining three species known from the New Zealand region, which are confined to the subantarctic islands. Neither *M. dubius* nor *M. phosphoreus* is regarded as endemic.

The other three species, *M. aucklandicus*, *M. campbellianus* and *M. macquariensis*, are regarded as endemic in the subantarctic islands.

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TABLE 6. Microscolex

——	*aucklandicus*	*campbellianus*
Length	78–93 mm.	50 mm.
Diameter	2·5–3·5 mm.	?
Segments	c. 100	65–85
Colour	reddish brown–brown chaetae on pale spots	dark chocolate brown chaetae on white spots
Clitellum	½xiii–½xvii	xiii–xvi
Extent of clitellum	½xiii–xv complete, xv–½xvii dorsal and lateral	complete
Prostomium	epilobous	epilobous
Prostatic papillae	rounded	rounded
Position of prost. pores	xvii, xix, b	xvii, xix, b
Position of male pores	a/b in seminal grooves, on xviii	b in seminal grooves, on xviii
Position of female pores	antero-medial to a	ventro-lateral
Position of spermathecal pores	7/8, 8/9 b	7/8, 8/9 a
Position of nephridiopores	c	c
Septal thickening	absent	?
Proventriculus	absent	?
Gizzard	v	vi
Nature of gizzard	small	only visible in sections
Oesophageal glands	xiii, xiv	oesoph. dilated in xi, xii
1st intestinal segment	xviii	xv
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	3
Last heart	xii	xii
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xi, xii botryoidal	ix, xi, xii sac
Prostates	xvii→, xix→	xvii, xix
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	2	2
Form	tubular	ovoidal
Position	enter duct in body wall	1 lateral, 1 medial
Nephridial vesicles	present	?

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TABLE 6. Microscolex—*continued*

dubius	*macquariensis*	*phosphoreus*
60–65 mm.	40 mm.	42 mm.
4 mm.	4·6 mm.	2 mm.
110	85	76
unpigmented	greenish brown anteriorly, otherwise unpigmented	unpigmented, phosphorescent
xiii–½xvii	xiii–xvi (xvii)	xiii–xvi (xvii)
complete	complete	complete
epilobous	epilobous	epilobous
small papillae on xvii, slightly lateral to chaeta a	small xvii, xix, a lateral to b, in seminal grooves, on xviii	small papillae on xvii, in position of a
anterior to a	anterior to a	?
not visible	7/8, 8/9. b	8/9 a
c	c	c
?	absent	?
absent	absent	absent
v	absent	absent or rudimentary
rudimentary	..	..
oesoph. dilated in ix, x, xi, xii, xiii	oesoph. dilated in xvi, xvii	absent
xvi	xx	xvi
unpaired	paired posterior to x/xi	unpaired
3	2	3
xii	xiii	xii
dorsal and supra-intest.vv.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii
racemose	racemose	racemose
xvii	xvii, xix	xvii–xviii
present	present	present
absent	absent	absent
spermathecae absent	2	1
..	ovoidal	club shaped
..	1 lateral, 1 medial	medial
present	present	present

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Their distribution gave rise to the hypothesis that they, and all the New Zealand Acanthodrilinae, had entered New Zealand by migration through the antarctic continent at a time when that continent had a warmer climate. The hypothesis was based on another hypothesis, namely that earthworms are unable to tolerate immersion in sea water and consequently can only be distributed over continuous areas of land. Michaelsen (1907a) states that *M. aucklandicus* and *M. campbellianus* are euryhaline. His statement is borne out by the occurrence of these species on and close to the shore, and by the occurrence of the same species on several subantarctic islands, which are widely separated in the southern ocean. As stated elsewhere (p. 410) there is reason to believe that the earthworm fauna of the subantarctic islands is of recent origin, and the possibility of there having been land connections between the islands and an antarctic continent with a mild climate as recently as would be necessary to explain the distribution of *Microscolex* is most unlikely.

M. aucklandicus, M. campbellianus, and *M. macquariensis* are quadriprostatic species with male pores in seminal grooves on xviii. They are closely similar morphologically, particularly *M. aucklandicus* and *M. campbellianus,* (see Table 6) and they probably arose recently from a common ancestral stock.

Microscolex aucklandicus (Benham). Figs. 77, 78

1903 *Notiodrilus aucklandicus* Benham, Trans. N.Z. Inst. 35:275–7.
1905 *Notiodrilus aucklandicus,* Benham, Trans. N.Z. Inst. 37:287.
1907 *Microscolex aucklandicus,* Michaelsen, Fauna Südwest-Aust. 1 (2): 143.
1909 *Notiodrilus aucklandicus,* Benham, Subant. Is. N.Z. 1:271.
1923 *Microscolex aucklandicus,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:219.
1930 *Acanthodrilus aucklandicus,* Stephenson, Oligochaeta p. 425.
1937 *Microscolex aucklandicus,* Pickford, Monograph p. 88.
1950 *Notiodrilus aucklandicus,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:29.
1952 *Microscolex aucklandicus,* Lee, Trans. roy. Soc. N.Z. 79:537.

Length 78–93 mm. Diameter 2·5–3·5 mm. About 100 segments.

Colour reddish brown anteriorly, brown posteriorly; chaetae surrounded by small pale spots.

Clitellum ½xiii–½xvii, complete on ½xiii–xv, dorsal and lateral on xvi–½xvii.

Prostomium epilobous.

Chaetae 8/segment: bc=cd>ab; aa=dd=2ab.

Prostatic pores on xvii, xix, on papillae, in line with chaeta b.

Male pores in seminal grooves, between chaetae a and b, on xviii.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Gizzard in v, small. Oesophageal glands in xiii, xiv. Intestine commences in xviii.

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Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, botryoidal. Prostates convoluted and tubular; two pairs arising in xvii and xix and extending to xxii and xxiv respectively. Penial chaetae present, beside prostatic ducts; tip somewhat spoon shaped, shaft has fine transverse serrated ridges (Fig. 77). Spermathecae in viii, ix; globular sac with narrow duct; two tubular diverticula open into spermathecal duct in body wall. (Fig. 78).

Nephridial vesicles present.

Type Locality: Auckland Island; W. B. Benham, 1902.

Type material in Otago Museum (No. A.56.27); 4 complete specimens and fragments, preservation fair.

Localities:

Subantarctic Islands: Ringdove Bay, Antipodes Is.; leaf mould; R. K. Dell, 5/11/50; 1 specimen. Sandy Bay, Enderby Id., Auckland Is.; leaf mould; R. K. Dell, 18/3/54; 21 specimens. Rose Id., Port Ross, Auckland Is.; under logs; R. K. Dell, 19/3/54; 3 specimens. Sandy Bay, Enderby Id., Auckland Is; under logs, forest; R. K. Dell, 18/3/54; 5 specimens. Near Derry Castle Reef, Enderby Id, Auckland Is.; under stones and logs; R. K. Dell, 17/3/54; 1 specimen. Lookout Hill, Ranui Cove, Auckland Is.; peat, rata forest; M. L. Leamy, 11/54; 4 specimens.

Previous Records (from Benham, 1909):

Adams Id., on *Pleurophyllum* meadow. Camp Cove Magnetic Station, flat grassy ground about 1 ft. above sea level. Masked Id., among the roots of *Stilbocarpa polaris*. Under logs in various parts of Auckland Islands.

Benham (1909) described two varieties of *M. aucklandicus, bollonsi,* and *pallidus*. The following are Benham's diagnoses of these varieties.

Microscolex aucklandicus var. **bollonsi** (Benham)

The variety was based on one specimen which resembled *M. aucklandicus aucklandicus* in all respects, except the following:

Colour paler than *M. aucklandicus aucklandicus*.

Chaetal formula: bc=cd>ab; dd>aa; ab>aa.

Spermathecal duct much wider and spermathecal sac smaller than in *M. aucklandicus aucklandicus*.

Tubercula pubertatis differ in number and position.

Type Locality: Disappointment Id., Auckland Is.; W. B. Benham, 1909.

Type specimen in Otago Museum (No. A.07.296), in good condition.

No further specimens of the variety have been seen since Benham's original collection.

Microscolex aucklandicus var. **pallidus** (Benham)

The variety is identical with *M. aucklandicus aucklandicus,* except in the following respects:

It is minute and colourless: (Length 23 mm., diameter 3·25 mm., 76 segments in Benham's type specimen).

The clitellum covers only xiv–xvi.

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Type Locality: Enderby Id., Auckland Is.; in logs; W. B. Benham, 1909.

Type specimen in Otago Museum (No. A.07.300), in good condition.

Localities:

Auckland Islands: Sandy Bay, Enderby Id.; leaf mould; R. K. Dell, 18/3/54; 4 specimens. Sandy Bay, Enderby Id.; under logs in forest; R. K. Dell, 18/3/54; 1 specimen.

Microscolex campbellianus (Benham). Fig. 79

1905 *Notiodrilus campbellianus* Benham, Trans. N.Z. Inst. 37:288.
1907 *Microscolex campbellianus,* Michaelsen, Fauna Südwest-Aust. 1 (2): 143.
1909 *Notiodrilus campbellianus,* Benham, Subant. Is. N.Z. 1:273–4.
1923 *Microscolex campbellianus,* Michaelsen, Vidensk. Medd. Dansk. naturh. Foren. 75:219.
1937 *Microscolex campbellianus,* Pickford, Monograph p. 88.
1950 *Notiodrilus campbellianus,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:29.

Length c. 50 mm. Diameter not known. 65–85 segments.

Colour, alternate dark chocolate brown and pale bands with paler clitellum, each chaeta arises from a small white spot.

Clitellum xiii–xvi, complete.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa=bc>ab; dd>aa.

Prostatic pores on xvii, xix, on rounded papillae, in line with chaeta b.

Male pores on xviii, in seminal grooves, in line with chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores slightly below line of chaeta c.

Gizzard in vi, only visible in sections. Oesophagus dilated in xi, xii. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, sac-like; those of ix smaller than those of xi, xii. Prostates commence in xvii, xix, extend back to xxii; tubular. Penial chaetae with slender, slightly undulating shaft, terminating in point; small serrated ridges surround distal end of chaeta (Fig. 79). Spermathecae in viii, ix; globular sac; two small ovoidal diverticula open into spermathecal duct, one lateral, one medial.

Nephridial vesicles not recorded.

Type Locality: Campbell Island; close to sea; W. B. Benham 1904.

Type material in Otago Museum (No. A.56.24); 3 specimens, poorly preserved; small polychaete also in container.

Previous Records:

Subantarctic Islands: Campbell Id.; on the shore; Cockayne, 1903 (from Benham, 1905). Campbell Id. and Auckland Is.; in logs and in bush soil on shore of Carnley Harbour; W. B. Benham, 1909. Tagua Bay, Auckland Is.; E. G. Turbott, 1944 (from Benham, 1950).

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Microscolex dubius (Fletcher)

1887 *Eudrilus? dubius* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 2:378
1887 *Microscolex modestus,* Rosa, Boll. Mus. zool. Anat. comp. Torino 3 (39) :4.
1889 *Microscolex dubius,* Rosa, Ann. Mus. Stor. nat. Genova 9 (2a) :511.
1893 *Microscoles modestus,* Smith, Trans. N.Z. Inst. 25:117.
1893 *Endrilus? dubius* (part?), Smith, Trans. N.Z. Inst. 25:117.
1895 *Microscolex dubius,* Beddard, Monograph pp. 461–2.
1900 *Microscolex dubius,* Michaelsen, Tierreich 10:140.
1907 *Microscolex dubius,* Michaelsen, Fauna Südwest-Aust. 1 (2) :146-8.
1937 *Microscolex dubius,* Pickford, Monograph p. 429.

Length 60–65 mm. Diameter 4 mm. 110 segments.

Colour unpigmented, with yellowish clitellum.

Clitellum xiii–$\frac{1}{3}$xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc>cd>ab.

Prostatic and male pores (combined) on small papillae on xvii, slightly lateral to position of chaeta a.

Female pores on xiv, slightly anterior to chaeta a.

Spermathecal pores not visible.

Nephridiopores slightly below line of chaeta c.

Gizzard in v, rudimentary. Oesophagus dilated in each segment from ix to xiii, but no definite glands. Intestine commences in xvi. Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts in x, xi, xii, connected to dorsal and supra-intestinal blood vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, narrow, tubular, of small size. Penial chaetae present; gently curved spine with free end faintly striated. Spermathecae absent.

Meganephridial; nephridial vesicles present.

Type Locality: Near Melbourne, Australia.

Localities: None.

The species was recorded in New Zealand by Smith (1892) from gardens at Ashburton. It has not been recorded again.

Microscolex macquariensis (Beddard). Figs. 80–82

1896 *Acanthodrilus macquariensis* Beddard, Proc. zool. Soc. Lond., 1896, p. 208.
1900 *Notiodrilus macquariensis,* Michaelsen, Tierreich 10:130.
1901 *Acanthodrilus macquariensis,* Benham, Trans. N.Z. Inst. 33:132–3.
1903 *Notiodrilus macquariensis,* Benham, Trans. N.Z. Inst. 35:276–7.
1905 *Notiodrilus macquariensis,* Cognetti de Martiis, Mem. R. Accad. Torino, 45:1–72.
1907 *Microscolex macquariensis,* Michaelsen, Fauna Südwest-Aust. 1 (2): 143.
1909 *Notiodrilus macquariensis,* Benham, Subant. Is. N.Z. 1:275.
1937 *Microscolex macquariensis,* Pickford, Monograph p. 593.

Length 40 mm. Diameter 4·6 mm. 85 segments.

Colour light greenish brown (in formalin) on dorsal aspect of anterior 30 segments, otherwise unpigmented.

Clitellum xiii–xvi (or xvii), complete.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc>ab; cd=bc.

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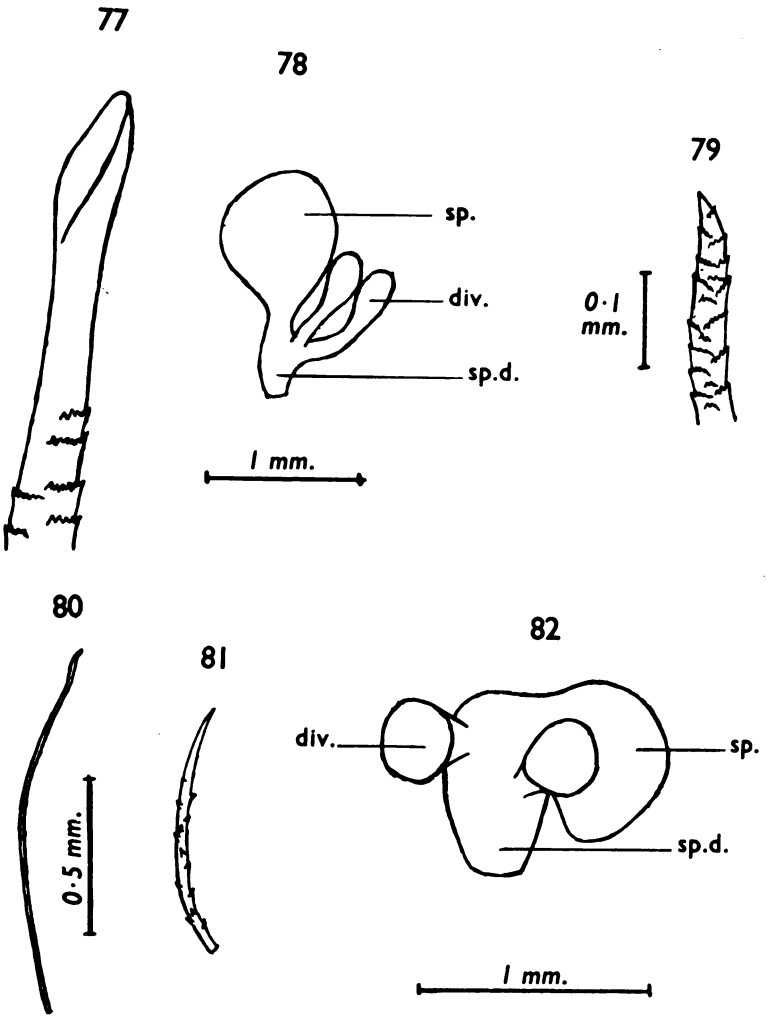
Prostatic pores on xvii, xix, on small papillae, in position of chaeta a.

Male pores in seminal grooves on xviii, slightly lateral to chaeta b. Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in single series in line with chaeta c.

No specially thickened septa.



FIGS. 77, 78. *Microscolex aucklandicus*
77. Tip of penial chaeta
78. Spermatheca
(Drawings after Benham, 1903a)

FIG. 79. *Microscolex campbellianus*. Tip of penial chaeta. (After Benham, 1905c)

FIGS. 80–82. *Microscolex macquariensis*
80. Penial chaeta
81. Tip of penial chaeta
82. Left posterior spermatheca, anterior aspect

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Gizzard absent. Oesophagus dilated in xvi, xvii, but no definite glands. Intestine commences in xx.

Dorsal blood vessel paired posterior to x/xi, but the two vessels fuse at the septa. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; slender shaft, ornamented with scattered triangular tubercles, rounded at the apex; tip of chaeta hooked (Figs. 80, 81). Spermathecae in viii, ix; pyriform sac with long thick muscular duct which is sharply bent about half way along its length; two small ovoidal diverticula open into the spermathecal duct, one at each side, at the bend in the duct. (Fig. 82).

Nephridial vesicles present.

Type Locality: Macquarie Island; F. E. Beddard, 1896.

Type specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Localities:

Macquarie Island; peat, tussock grassland; J. S. Bunt, 1953; 1 specimen.

Microscolex phosphoreus (Dugès)

1837 *Lumbricus phosphoreus* Dugès, Ann. Sci. nat., ser. 2, 8:17–24.
1893 *Microscolex nova zelandiae* Beddard, Proc. R. phys. Soc. Edinb. 12:33.
1893 *Endrilus dubius* (part), Smith, Trans. N.Z. Inst. 25:117.
1894 *Rhododrilus novaezelandiae*, Eisen, Mem. Calif. Acad. Sci. 2 (3): 22.
1895 *Microscolex novae-zealandiae*, Beddard, Monograph, p. 463.
1900 *Microscolex novaezelandiae*, Michaelsen, Tierreich 10:139.
1900 *Microscolex phosphoreus*, Michaelsen, Tierreich 10:141.
1901 *Microscolex novae-zealandiae*, Benham, Trans. N.Z. Inst. 33:142.
1907 *Microscolex phosphoreus*, Michaelsen, Fauna Südwest-Aust. 1 (2):148.
1937 *Microscolex phosphoreus*, Pickford, Monograph p. 88.

The following diagnosis of the species is taken from the descriptions given by Beddard (1893), Michaelsen (1900) and Pickford (1937).

Length 42 mm. Diameter 2 mm. 76 segments.

Colour unpigmented, phosphorescent when alive.

Clitellum xiii–xvi (or xvii), complete.

Prostomium epilobous.

Chaetae 8/segment: aa=bc; dd>aa>cd>ab.

Male and prostatic pores (combined) on papillae on xvii, in line with chaeta a.

Female pores not mentioned.

Spermathecal pores at 8/9, in line with chaeta a.

Nephridiopores of ii–iv in line with chaeta d, posterior to iv in line with chaeta c.

Gizzard absent (according to Beddard, 1893) or rudimentary (according to Michaelsen 1900). Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xviii, tubular. Penial chaetae present; long slender shaft, gently curved in "S"-shape, with blunt tooth-like processes arranged in rows. Spermathecae in viii, with single, short,

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club-shaped, medial diverticulum. (Pickford (1937) describes specimens with a single diverticulum and others with two diverticula, one lateral and one medial.)

Nephridial vesicles present.

Type Locality: Unknown.

Remarks: This species has apparently not been re-collected from New Zealand since the original record of its occurrence.

Genus Octochaetus Beddard

1892 *Octochaetus* Beddard, Proc. zool. Soc. Lond., 1892, p. 668.
1896 *Benhamia* (part), Fedarb, J. Bombay nat. Hist. Soc. 11:432.
1900 *Octochaetus,* Michaelsen, Tierreich 10:319.
1920 *Octochaetus* (*Octochaetus*), Michaelsen, Mitt. zool. Mus. Hamb. 38:37.
1930 *Octochaetus* (*Octochaetus*), Stephenson, Oligochaeta p. 844.
1950 *Octochaetus* + *Cryptochaeta,* Benham, Trans. roy. Soc. N.Z. 78:324.
1952 *Octochaetus,* Lee, Trans. roy. Soc. N.Z. 79:558.

Lightly pigmented or unpigmented worms, living in topsoil or subsoil. Chaetae eight per segment. Clitellum developed over five to nine segments between xii and xx. Prostatic pores two pairs, usually on papillae, on xvii, xix. Seminal grooves present. Male pores on xviii, in seminal grooves. Female pores on xiv, paired, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9, ventro-lateral. Usually some thickened muscular septa between gizzard and first intestinal segment. Gizzard single, strongly developed, anterior to septum viii/ix. Dorsal blood vessel usually paired (in one species unpaired, and in one species the two vessels are joined by a slender transverse vessel in each segment); three or four pairs of hearts, the last in xii or xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates two pairs, opening to the exterior in xvii, xix, each usually confined to a single segment. Penial chaetae absent (present in *O. antarcticus*?). Copulatory muscles sometimes present. Spermathecae two pairs, in viii, ix; diverticula, if present, in same segment as spermathecal sac. Micronephridia numerous, usually in lateral bands, sometimes in lateral or ventro–lateral tufts in each segment.

Type species: *Octochaetus multiporus* Beddard.

Number of Species: Eleven.

Distribution: New Zealand; confined to the southern and eastern portions of the North Island; South Island; Stewart Island. (Fig. 360).

This genus was established by Beddard (1892) for a number of micronephridial species from New Zealand which had previously been referred to *Acanthodrilus.* It subsequently became the type genus of the subfamily Octochaetinae. Since some Indian species were referred to *Octochaetus,* there has been considerable argument on the relationship between Indian and New Zealand earthworms. The Indian species were separated from the New Zealand group, in the subgenus *Octochaetoides,* by Michaelsen (1920). Michaelsen also recognised a genus, *Monogaster,* from Africa, which, according to his definition, is indistinguishable from *Octochaetus,* but he allotted it a place in his "family tree' of generic relationships far removed from *Octochaetus,* in the now discarded subfamily Diplocardiinae. The New Zealand

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species here included in *Octochaetus* are considered to be unrelated to species referred to the Indian subgenus *Octochaetoides* and *Monogaster*. They have probably evolved within the New Zealand region and are considered to be closely related to *Eodrilus*. Until a revision of the Indian species of *Octochaetus* (*Octochaetoides*) is undertaken the question will remain in doubt, but differences not formerly noted may be found between the New Zealand and the Indian groups.

Eleven species are listed in this work. Three, *O. kapitiensis, O. pelorus* and *O. ravus,* are new species. Two species which have been formerly ascribed to the genus (*O. levis* (Hutton) and *O. microchaetus* (Benham)) are insufficiently described for identification and are listed as *species incertae sedis.*

KEY TO THE SPECIES OF OCTOCHAETUS

a_1 Gizzard confined to v
  b_1 Dorsal blood vessel unpaired; spermatheca with one small, rounded, anterior diverticulum ..... **O. brucei**
  b_2 Dorsal blood vessel paired; spermatheca with small cluster of very small diverticula ..... **O. huttoni**
a_2 Gizzard confined to vi or in v–vi
  c_1 Oesophageal glands one pair, in xv, or in xv and part xvi.
    d_1 Spermatheca without diverticula ..... **O. michaelseni**
    d_2 Spermatheca with two tubular diverticula, one antero-medial, one postero-medial ..... **O. sylvestris**
    d_3 Spermatheca with numerous small ovoidal diverticula surrounding spermathecal duct ..... **O. ravus**
  c_2 Oesophageal glands one pair, in xvii .
    e_1 Dorsal blood vessel paired throughout its length ..... **O. multiporus**
    e_2 Dorsal blood vessel paired throughout its length, but two vessels joined by a short transverse vessel posterior to each septum ..... **O. thomasi**
a_3 Gizzard confined to vii, or in vi–vii, or vii–viii
  f_1 Oesophageal glands one pair, in the region of xiv–xvi
    g_1 Septal thickening absent ..... **O. pelorus**
    g_2 Some septa in anterior region thickened and muscular
      h_1 Vesiculae seminales three pairs, in ix, xi, xii; spermatheca with four diverticula, two lateral and two medial ..... **O. kapitiensis**
      h_2 Vesiculae seminales four pairs, in ix, x, xi, xii; spermatheca with three diverticula, one anterior and two posterior ..... **O. tricystis**
  f_2 Oesophageal glands two (or three) pairs, in (xiv), xv, xvi ..... **O. antarcticus**

The species of the genus *Octochaetus* form a compact group, with only small differences distinguishable between the species (see Table 7). Certain groups of species are, however, recognisable. Variations in the arrangement of the micronephridial tubules enable an initial division to be made. Two species, *O. pelorus* and *O. ravus,* have the nephridia grouped in a compact ventro-lateral cluster on each side of each segment, while in the remainder of the species the nephridia are spread out in a band on the lateral aspects of the peritoneum. Of the latter group, *O. michaelseni, O. multiporus, O. thomasi, O. brucei, O. sylvestris,* and *O. tricystis* have the nephridia in a narrow band, while *O. antarcticus, O. huttoni* and *O. kapitiensis* have a broad band of nephridial tubules. *O. michaelseni, O. multiporus* and *O. thomasi* possess copulatory muscles, associated with the prostates, while the remaining species do not. If the distribution within New Zealand of the various species is examined, the relationships of groups of species become more obvious.

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TABLE 7. Octochaetus

	antarcticus	*brucei*
Length	240 mm.	175 mm.
Diameter	7 mm.	9 mm.
Segments	176	431
Colour	pale pink	pink
Clitellum	xiii–xvii	..
Extent of clitellum	dorsal and lateral	..
Prostomium	epilobous	prolobous
Prostatic papillae	prominent	low, rounded
Position of prostatic pores	b	a/b
Position of male pores	lateral to b in seminal grooves	a/b in seminal grooves
Position of female pores	?	antero-medial to a
Position of spermathecal pores	7/8, 8/9 a/b	7/8, 8/9 a/b
Septal thickening	vii/viii–xi/xii	v/vi–xiii/xiv
Proventriculus	? (probably in v)	absent
Gizzard	vi–vii	v
Nature of gizzard	strong	strong
Oesophageal glands	(xiv), xv, xvi	xvi
1st intestinal segment	?	xix
Dorsal blood vessel	paired	unpaired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.vv.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii: ix, x sac; xi, xii racemose	xi, xii sac
Prostates	xvii, xix	xvii, xix
Penial chaetae	present (?)	absent
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	3 (4)	1
Form	small, ovoid	rounded
Position	?	anterior
Micronephridial tubules	lateral band	narrow lateral band

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TABLE 7. Octochaetus—*continued*

huttoni	*kapitiensis*	*michaelseni*	*multiporus*
130 mm.	113 mm.	210 mm.	180–300 mm.
7 mm.	4·5 mm.	8 mm.	8–10 mm.
233	152	c. 200	200
pink	brick red	pink	unpigmented
xiii–xix (xx)	xiii–xix	xv–xix	½xiii–½xx
dorsal and lateral	dorsal and lateral	dorsal and lateral	xiv–½xv complete elsewhere dors. and lat.
prolobous	epilobous	epilobous	prolobous
on a ridge	absent	prominent	on ridge
ventro-lateral	lateral to b	b	lateral to b
ventro-lateral	lateral to b	lateral to b	lateral to b
in seminal grooves	in seminal grooves	in seminal grooves	in seminal grooves
ventro-lateral	medial to a	antero-medial to a	antero-medial to a
7/8, 8/9	7/8, 8/9	7/8, 8/9	7/8, 8/9
a/b	b	b	b
v/vi–xi/xii	x/xi–xiii/xiv	v/vi–xii/xiii	vi/vii–xii/xiii
absent	v–vi	v	v
v	vii–viii	vi	vi
strong	large, strong	long, strong	large, strong
xv, xvi	xv	xv	xvii
xviii	xviii	xvi	xix (xx)
paired	paired	paired post. to vii/viii	paired
3	4	4	4
xii	xiii	xiii	xiii
dorsal b.vv.	dorsal b.vv.	dorsal b.vv.	supra-intest. v.
x, xi	x, xi	x, xi	x, xi
xi, xii	ix, xi, xii	xi, xii	xi, xii
?	sac	racemose	racemose
xvii, xix	xvii, xix	xvii, xix	xvii, xix
absent	absent	absent	absent
absent	absent	present	present
numerous small cluster of small div.	4 small, round	absent ..	absent ..
.. broad lateral band	2 lateral, 2 medial broad lateral band	.. narrow lateral band	.. narrow lateral band

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TABLE 7. Octochaetus—*continued*

——	*pelorus*	*ravus*
Length	58·5 mm.	182 mm.
Diameter	3·25 mm.	7 mm.
Segments	148	172
Colour	pale pink	pink
Clitellum	xiii–xvii	xiii–xvii
Extent of clitellum	xiv–xvi complete elsewhere dors. and lat.	dorsal and lateral
Prostomium	prolobous	tanylobous
Prostatic papillae	low, rounded	small, rounded
Position of prostatic pores	lateral to b	b
Position of male pores	lateral to b in seminal grooves	lateral to b in seminal grooves
Position of female pores	near anterior margin and ventral mid line	antero-medial to a
Position of spermathecal pores	7/8, 8/9 b	7/8, 8/9 ventro-lateral
Septal thickening	absent	vii/viii–xi/xii
Proventriculus	v–vi	v
Gizzard	vii	vi
Nature of gizzard	long, strong	wide, strong
Oesophageal glands	dilated in ½xiv–xvi	xv–½xvi
1st intestinal segment	xviii	xvii
Dorsal blood vessel	paired posterior to x/xi	paired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	supra-intest. v.	supra-intest. v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii: ix, x sac; xi, xii racemose	x, xi, xii: x sac; xi, xii racemose
Prostates	xvii–xvi xix–xxi	xvii, xix
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	3	numerous
Form	small, ovoid, with long duct	small, ovoidal
Position	medial	surround duct
Micronephridial tubules	compact lateral tuft	ii–x ventro-lateral tufts; posterior to x in lateral bands

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TABLE 7. Octochaetus—*continued*

sylvestris	*thomasi*	*tricystis*
87 mm.	140 mm.	82 mm.
4 mm.	5 mm.	5 mm.
154	210	94
pink	pale brown	unpigmented
xiii–xvii	xiii–xix	½xiii–xvii
dorsal and lateral	xiv–xv complete elsewhere dors. and lat.	dorsal and lateral
tanylobous	prolobous	prolobous
small, rounded	prominent	small, rounded
lateral to a	lateral to b	lateral to b
a/b	lateral to b	lateral to b
in seminal grooves	in seminal grooves	in seminal grooves
antero-medial to a	anterior to a	antero-medial to a
7/8, 8/9	7/8, 8/9	7/8, 8/9
a/b	b	b
absent	vi/vii–xii/xiii	ix/x–xii/xiii
v	absent	v–vi
vi	v–vi	vii
large, strong	strong	wide, strong
xv	xvii	xv
xviii	xix	xviii
paired, post. to vii/viii	paired, connected in each segment	paired
4	4	4
xiii	xiii	xiii
dorsal b.vv.	supra-intest. v.	supra-intest. v.
x, xi	x, xi	x, xi
xi, xii	xi, xii	ix, x, xi, xii: ix, x,
racemose	racemose	sac; xi, xii racemose
xvii, xix	xvii, xix	xvii, xix
absent	absent	absent
absent	present	absent
2	numerous	3
tubular	small granular swellings on duct	small, ovoidal
1 antero-medial	surround duct	1 anterior,
1 postero-medial		2 posterior
narrow lateral band	narrow lateral band	narrow lateral band

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Species of *Octochaetus* are found throughout the South Island and in the southern portion of the North Island and Kapiti Island. One species, *O. multiporus,* is found in both islands and is very common. In the North Island, *O. brucei, O. sylvestris* and *O. tricystis* are at the northern end of the range of the genus; these species, although they form a distinct group on morphological grounds, are closely related to the *O. multiporus, O. michaelseni, O. thomasi* group. *O. multiporus* and *O. michaelseni* are found in the south of the North Island. In the South Island *O. multiporus* is widely distributed east of the main divide, on the northern coast of the island and in Stewart Island. *O. thomasi* very closely resembles *O. multiporus* and its distribution closely parallels that of *O. multiporus,* but extends down the west coast for some distance from the north. Few records are available for *O. antarcticus* and *O. huttoni,* but their distribution falls within the range of *O. multiporus. O. kapitiensis* is confined to Kapiti Island. It does not closely resemble the North Island species, but is most similar to *O. antarcticus* and *O. huttoni.* The relationships of the Kapiti Island fauna are discussed elsewhere. *O. pelorus* and *O. ravus* are within the area occupied by *O. multiporus,* but in their morphology are more closely related to *O. kapitiensis* than to *O. multiporus.*

Octochaetus antarcticus Beddard. Fig. 83

1889 *Acanthodrilus antarcticus* Beddard, Proc. zool. Soc. Lond., 1889, p. 378.
1890 *Acanthodrilus antarcticus,* Beddard, Quart. J. micr. Sci. 30:428–32.
1890 *Acanthodrilus antarcticus,* Beddard, Proc. zool. Soc. Lond., 1890, p. 59.
1890 *Acanthodrilus antarcticus,* Benham, Quart. J. micr. Sci. 31:230.
1890 *Acanthodrilus antarcticus,* Beddard, Quart. J. micr. Sci. 31:484.
1891 *Acanthodrilus antarcticus,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Octochaetus antarcticus,* Beddard, Proc. zool. Soc. Lond., 1892, p. 671.
1893 *Acanthodrilus antarcticus,* Smith, Trans. N.Z. Inst. 25:127–9.
1894 *Octochaetus antarcticus,* Smith, Trans. N..Z. Inst. 26:165.
1895 *Octochaetus antarcticus,* Beddard, Monograph p. 553.
1900 *Octochaetus antarcticus,* Michaelsen, Tierreich 10:320.
1905 *Octochaetus antarcticus,* Ude, Z. wiss. Zool. 83.
1952 *Octochaetus antarcticus,* Lee, Trans. roy. Soc. N.Z. 79:559.

This species has not been re-collected in the present study, and the following diagnosis is based on those of Beddard (1890, 1895), Smith (1892, 1893), Michaelsen (1900) and Ude (1905).

Length 240 mm. Diameter 7 mm. 176 segments.

Colour pale pink with red clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc; bc=cd>ab.

Prostatic pores on prominent papillae on xvii, xix, in line with chaeta b.

Male pores on xviii, in seminal grooves, lateral to chaeta b.

Female pores on xiv.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Septa vii/viii–xi/xii thickened.

Gizzard in vi–vii. Oesophageal glands in xv, xvi (and xiv?). Intestine not mentioned.

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Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii; those of ix, x compact, small, sac-like, those of xi, xii racemose, large. Prostates in xvii, xix, tubular, coiled. Penial chaetae present (Beddard (1890) states that "penial chaetae are present on both the seventeenth and nineteenth segments." This is the only species of *Octochaetus* in which penial chaetae are known to occur. Beddard does not figure a fully developed penial chaeta, but figures an immature one (Fig. 83)). Spermathecae in viii, ix, each with three or four small diverticula.

Micronephridia present.

Type Locality: Ashburton; F. E. Beddard, 1889.

Slide only, T.S. of calciferous glands, held in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Octochaetus brucei Lee. Fig. 84

1952 *Octochaetus brucei* Lee, Trans. roy. Soc. N.Z. 79:562-3.

Length 175 mm. Diameter 9 mm. 431 segments.

Colour pink..

No noticeable clitellum.

Prostomium prolobous.

Chaetae 8/segment, very closely paired, all visible from ventral aspect: ab=cd; aa>bc; dd≫aa; bc≫ab.

Prostatic pores on low rounded papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetae ab.

Septa v/vi–xiii/xiv thickened.

Gizzard in v. Oesophageal glands in xvi. Intestine commences in xix.

Dorsal blood vessel unpaired. Hearts in x, xi, xii, xiii, from dorsal blood vessel.

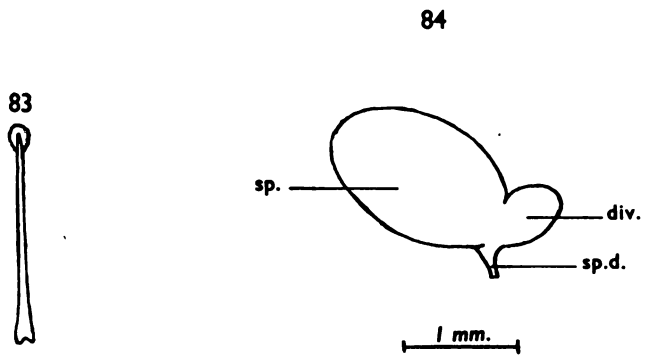

FIG. 83. *Octochaetus antarcticus.* Penial chaeta. (After Beddard, 1890)

FIG. 84. *Octochaetus brucei.* Right posterior spermatheca, lateral aspect

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Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, sac-like. Prostates in xvii, xix, tubular, convoluted. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; ovoidal sac with short narrow duct; anterior, rounded diverticulum, not sharply differentiated from sac. (Fig. 84).

Micronephridia in each segment except i; those of ii in small, compact, ventro-lateral clusters; posterior to ii the tubules are in narrow bands across the lateral aspects of the peritoneum.

Type Locality: R. C. Bruce Memorial Park, Hunterville; subsoil, podocarp forest; K.E.L. 11/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Mangaweka; subsoil, podocarp forest; K.E.L., 13/10/50; 5 specimens. Mokai Patea, 3,700 ft.; litter mound of dead cedar; A. C. S. Wright, 2/51; 2 specimens.

Octochaetus huttoni Beddard

1892 *Octochaetus huttoni* Beddard, Proc. zool. Soc. Lond., 1892, p. 674.
1894 *Octochaetus huttoni,* Smith, Trans. N.Z. Inst. 26:170–1.
1895 *Octochaetus huttoni,* Beddard, Monograph p. 552.
1895 *Acanthodrilus huttoni,* Beddard, Monograph p. 526.
1900 *Octochaetus huttoni,* Michaelsen, Tierreich 10:230.
1905 *Octochaetus huttoni,* Ude, Z. wiss. Zool. 83.
1952 *Octochaetus huttoni,* Lee, Trans. roy. Soc. N.Z. 79:558.

Length 130 mm. Diameter 7 mm. 233 segments, all with secondary annulations.

Colour pink with white clitellum.

Clitellum xiii–xix (xx), dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment; widely spaced.

Prostatic pores on xvii, xix. Male pores in seminal grooves on xviii. Prostatic pores and seminal grooves on a ventro-lateral longitudinal ridge which overhangs the ventral surface.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, 8/9, anterior to chaetal interval ab.

Septa v/vi to xi/xii thickened. No septa anterior to iv/v.

Gizzard in v. Oesophageal glands in xv, xvi. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii. Prostates in xvii, xix, tubular, convoluted. Spermathecae in viii, ix; small cluster of minute diverticula very close together and resembling a solid body.

Micronephridia numerous, in a band across the lateral aspects of the peritoneum; there is a particularly dense mass of tubules in the anterior segments.

Type Locality: Banks of Albury Creek, South Canterbury; Beddard and Smith, 1892.

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Type (?) specimen in British Museum (Nat. Hist.), Collection registration no. 1904. 10.

Localities:

South Island: Caswell Sound; topsoil, beech forest; R. R. Forster, 14/4/49; 1 specimen. Angus Burn, W. Southland; subsoil, beech forest; A. C. S. Wright, 13/1/49; 4 specimens.

Stewart Island: Rakeahua Flats; subsoil, beech forest; A. C. S. Wright, 12/49; 1 specimen.

Octochaetus kapitiensis n.sp. Figs. 85–87

Length 113 mm. Diameter 4·5 mm. 152 segments.

Colour brick red dorsally, pale ventrally, with brown clitellum.

Clitellum xiii–xix, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc>cd>ab.

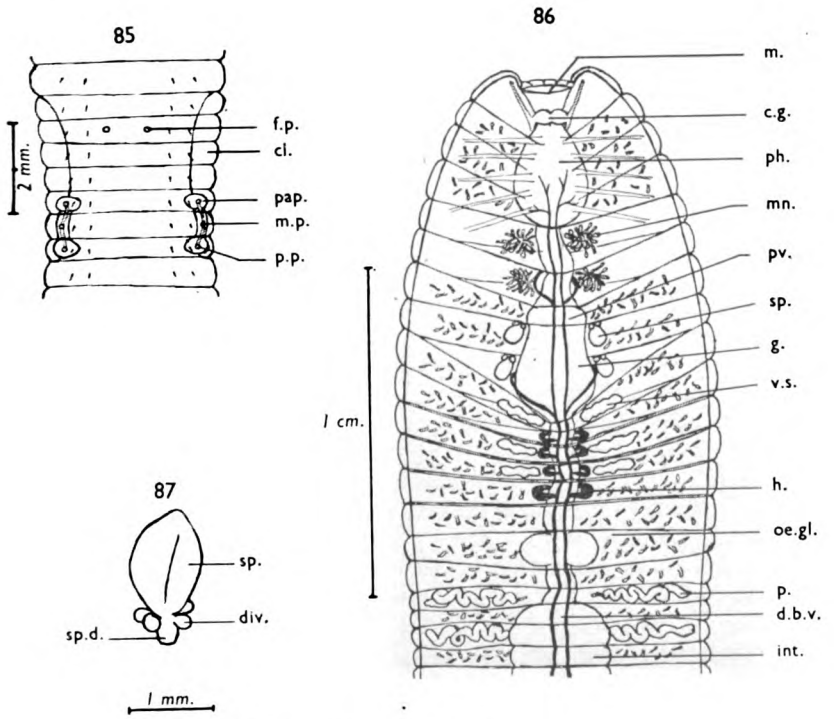
Prostatic pores on xvii, xix, slightly lateral to chaeta b, each in the centre of a small pale area, not on papillae.

Male pores in seminal grooves on xviii, slightly lateral to chaeta b.

Female pores on xiv, medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa x/xi to xiii/xiv thickened.



FIGS. 85–87. *Octochaetus kapitiensis* n.sp.
85. Ventral aspect, segments xii–xx
86. Dissection from dorsal aspect, segments i–xx
87. Right anterior spermatheca, anterior aspect

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Pharynx in i–iv. Proventriculus in v–vi, narrow. Gizzard in vii–viii, large and muscular. Oesophageal glands in xv, large. Intestine commences in xviii.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, sac-like. Prostates in xvii, xix, tubular, convoluted. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; dorso-ventrally flattened oval sac with short wide duct; four small round diverticula, two on each side of anterior aspect of spermathecal duct. (Fig. 87).

Micronephridia commence in ii; in ii–iv a few tubules are scattered over the lateral aspects of the peritoneum; in v and vi the tubules are arranged in ventro-lateral compact clusters of 100 or more on each side, the whole mass connected by a thin-walled duct to the ventro-lateral aspect of the pharynx and probably functioning as a salivary gland; posterior to vi the tubules are arranged in a broad band on each side of each segment.

Type Locality: Kapiti Island, about 300 yd. S. of caretaker's house: topsoil, coastal forest; K.E.L., 28/1/54.

Type specimen in Soil Bureau collection.

Localities:

Kapiti Island: Same data as type material; 4 specimens. East side of island, 600–700 ft., Trig track; topsoil, coastal forest; K.E.L., 28/1/54; 1 specimen. Trig track, 1400 ft.; topsoil, coastal forest; K.E.L., 26/1/54; 4 specimens. East side of island, steep hillside above cliff; topsoil, coastal scrub; K.E.L., 27/1/54; 4 specimens. East side of island, steep slope near north end; litter and shingle, coastal forest; 2 specimens.

Octochaetus michaelseni Benham. Fig. 88

1904 *Octochaetus michaelseni* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 220.
1905 *Octochaetus michaelseni,* Benham, Trans. N.Z. Inst. 37:282.
1952 *Octochaetus michaelseni,* Lee, Trans. roy. Soc. N.Z. 79:558.

Length 210 mm. Diameter 8 mm. c. 200 segments.

Colour pink with purplish red clitellum.

Clitellum xv–xix, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment; ab=bc; aa=cd>ab; dd>aa.

Prostatic pores on prominent ventro-lateral papillae on xvii, xix, in line with chaeta b.

Male pores in seminal grooves on xviii.

Female pores on xiv.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa v/vi to xii/xiii thickened.

Gizzard in vi, long. Oesophageal glands in xv, large and hemispherical. Intestine commences in xvi.

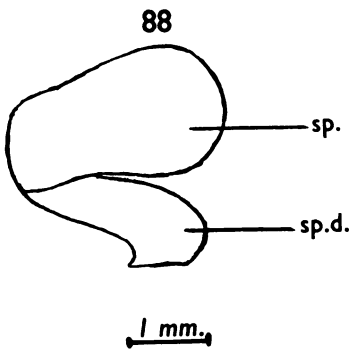

FIG. 88. *Octochaetus michaelseni.* Spermatheca. (After Benham, 1904b)

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Dorsal blood vessel paired posterior to vii/viii. Hearts in x, xi, xii, xiii, from dorsal blood vessel.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, coiled. Penial chaetae absent. Spermathecae in viii, ix; simple ovoidal sac with short thick duct forming an acute angle with the sac; there is apparently no diverticulum but there seem to be a number of small saccules arranged irregularly and imbedded in the wall of the duct. (Fig. 88).

Micronephridia arranged in narrow lateral bands.

Type Locality: Wellington; W. B. Benham, 1904.

The type material of this species has not been located.

Localities:

North Island: Tinui, Wairarapa; subsoil, pasture; K.E.L., 17/4/50; 2 specimens. Wairongomai, Wairarapa; topsoil, beech forest; K.E.L., 19/4/50; 2 specimens. Miramar, Wellington; garden soil; D. Morgan, 11/50; 3 specimens. Taita, Lower Hutt; subsoil, beech forest; K.E.L., 12/12/52; 1 specimen.

Octochaetus multiporus (Beddard)

1885 *Acanthodrilus multiporus* Beddard, Proc. zool. Soc. Lond., 1885, p. 813.
1886 *Acanthodrilus multiporus,* Beddard, Proc. zool. Soc. Lond., 1886, p. 170.
1887 *Acanthodrilus* sp. nov., Smith, Trans. N.Z. Inst. 19:135–6.
1889 *Acanthodrilus multiporus,* Beddard, Quart J. micr. Sci. 29:101.
1889 *Acanthodrilus multiporus,* Beddard, Quart. J. micr. Sci. 29:242.
1889 *Acanthodrilus multiporus,* Beddard, Proc. zool. Soc. Lond., 1889, p. 378.
1890 *Acanthodrilus multiporus,* Beddard, Quart. J. micr. Sci. 30:422.
1890 *Acanthodrilus multiporus,* Benham, Quart. J. micr. Sci. 31:230.
1890 *Acanthodrilus multiporus,* Beddard, Quart. J. micr. Sci. 31:479–86.
1890 *Acanthodrilus multiporus,* Beddard, Proc. zool. Soc. Lond., 1890, p. 59.
1891 *Acanthodrilus multiporus,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Octochaetus multiporus,* Beddard, Proc. zool. Soc. Lond., 1892, p. 674.
1893 *Acanthodrilus multiporus,* Smith, Trans. N.Z. Inst. 25:114.
1894 *Octochaetus multiporus,* Smith, Trans. N.Z. Inst. 26:157.
1895 *Octochaetus multiporus,* Beddard, Monograph p. 551.
1900 *Octochaetus multiporus* (incl. *O. thomasi*), Michaelsen, Tierreich 10: 319.
1901 *Octochaetus multiporus,* Benham, Quart. J. micr. Sci. 44:565–90.
1903 *Octochaetus multipores,* Benham, Trans. N.Z. Inst. 35:289.
1905 *Octochaetus multiporus,* Ude, Z. wiss. Zool. 83.
1919 *Octochaetus multiporus,* Stephenson, Trans. roy. Soc. Edinb. 52:464.
1952 *Octochaetus multiporus,* Lee, Trans. roy. Soc. N.Z. 79:559.
1952 *Octochaetus multiporus,* Lee, Trans. roy. Soc. N.Z. 80:35.

Length 180–300 mm. Diameter 8–10 mm./c. 200 segments, with three to five secondary annulations.

Colourless with reddish purple clitellum; a streak of purple runs along the dorsal mid line.

Clitellum ½xiii to ½xx, complete on xiv–½xv, otherwise dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment: ab=cd; dd>aa>bc>ab.

On xvii–xix on each side there is a very prominent longitudinal ridge, slightly lateral to chaeta b. The two prostatic pores of each side

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are on these ridges, on xvii and xix, and the male pores are on xviii, lateral to chaeta b, in the seminal grooves, which run along the longitudinal ridges.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Septa vi/vii to xii/xiii thickened. No septa anterior to iv/v.

Gizzard in vi (sometimes extending slightly into v). Oesophageal glands in xvii. Intestine commences in xix (or xx).

Dorsal blood vessel paired. Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix; very long, coiled, tubular. Penial chaetae absent (?) (Ude (1905) says they are present, but I have not found them and do not believe that they exist). Copulatory muscles present. Spermathecae in viii, ix; long ovoidal sac with long duct; diverticula absent.

Micronephridia very numerous; in the anterior region they are concentrated in a large cluster on each side, and from the cluster arises a slender duct which extends forwards and opens into the buccal cavity or the pharynx.

Type Locality: Canterbury Plains; F. E. Beddard, 1885.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Localities:

North Island: Waikanae; topsoil, coastal forest; K.E.L., 1/9/49; 2 specimens. Tuhitarata, Wairarapa; subsoil, scrub; K.E.L., 30/8/49; 2 specimens. Wairongomai, Wairarapa; topsoil, beech forest; K.E.L., 19/4/50; 1 specimen. Whitemans Valley, near Wellington; topsoil, manuka scrub; K.E.L., 1/9/49; 4 specimens. Wallaceville; subsoil, manuka scrub; K.E.L., 1/9/49; 1 specimen. Taita, Lower Hutt; topsoil and subsoil, manuka scrub; K.E.L., 19/7/54; 16 specimens. Taita, Lower Hutt; subsoil, manuka scrub; K.E.L., 5/54; 18 specimens. Summit of Mt. Wainui, near Paekakariki; subsoil, scrub; K.E.L., 12/10/53; 5 specimens.

Kapiti Island: Flat ridge-top, Kapiti Trig; subsoil, grass and bracken; K.E.L., 26/1/54; 3 specimens. Trig track, 1,300 ft.; subsoil, coastal forest; K.E.L., 26/1/54; 1 specimen. Spur above W. end of Rangitira Bay, 200–300 ft.; subsoil, coastal forest; K.E.L., 26/1/54; 4 specimens.

South Island: Kaiteriteri, near Motueka; subsoil, manuka scrub; K.E.L., 27/5/54; 5 specimens. Kaiteriteri; subsoil, beech forest; K.E.L., 27/5/54; 1 specimen. Takaka; subsoil, beech forest; K.E.L., 27/5/54; 2 specimens. Nelson; subsoil, scrub; K.E.L., 28/5/54; 1 specimen. Moutere Hills; subsoil, manuka scrub; K.E.L., 25/5/54; 5 specimens. Whangamoa Saddle, Nelson; topsoil, beech forest; K.E.L., 26/5/54; 4 specimens. Whangamoa Saddle; subsoil, beech forest; K.E.L., 26/5/54; 3 specimens. Lee R. valley, Nelson; subsoil, beech forest; K.E.L., 26/5/54; 2 specimens. Picton; subsoil, coastal forest; K.E.L., 1/6/54; 3 specimens. ½ mile N.E. of Picton; subsoil, beech forest; K.E.L., 1/6/54; 10 specimens. 2 miles S. of Picton; topsoil, rough pasture; K.E.L., 1/6/54; 3 specimens. 2 miles N. of Branch River, Wairau Valley; subsoil, manuka scrub; K.E.L., 31/5/54; 1 specimen. Near Wash Bridge, Wairau Valley, 3,400 ft.; subsoil, tussock grassland; K.E.L., 31/5/54; 5 specimens. Vernon, near Blenheim; subsoil, manuka scrub; K.E.L., 29/5/54; 1 specimen. Awatere Valley; topsoil, forest; K.E.L., 30/5/54; 1 specimen. Eyredale, N. Canterbury; topsoil, manuka scrub; A. C. S. Wright, 15/8/51; 1 specimen. Rangiora, N. Canterbury; subsoil, rushes; A. C. S. Wright, 15/8/51; 3 specimens. Mt. Somers, N. Canterbury; subsoil, tussock grassland; A. C. S. Wright, 19/8/51; 5 specimens. Ashwick, N. Canterbury; subsoil, tussock grassland; A. C. S. Wright, 20/8/51; 2 specimens. Opuha, N. Canterbury; topsoil, pasture; A. C. S. Wright, 20/8/51; 3 specimens. Pukerau, N. Canterbury; subsoil, tussock grassland; A C. S. Wright, 22/8/51; 3 specimens. Motunau Island; surface, tussock grassland;

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R. H. Taylor, 15/6/54; 1 specimen. Fraser's Dam Road, near Alexandra, 3,000 ft.; subsoil, tussock grassland; K.E.L., 12/10/53; 6 specimens. Flagstaff, Dunedin; tussock grassland; K. Paviour-Smith, 25/4/54; 1 specimen. Upper Stillwater R., Caswell Sound; R. R. Forster, 13/4/49; 1 specimen.

Stewart Island: Rocky Hill; subsoil, beech forest; A. C. S. Wright, 12/50; 10 specimens. Island Hill; topsoil, manuka scrub; A. C. S. Wright, 12/50; 3 specimens.

Previous Records:

South Island: Canterbury Plains; Beddard, 1885. Canterbury Plains, Rangitata Gorge, Oamaru; W. W. Smith, 1887. Waipara, South Canterbury; H. Ude, 1905.

Octochaetus pelorus n.sp. Figs. 89–91

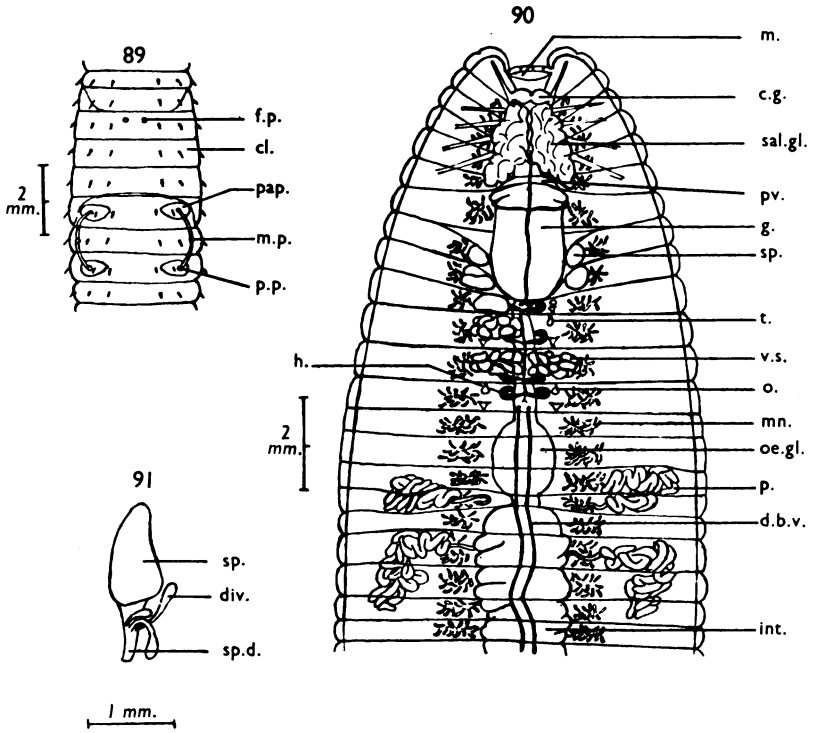
Length 58·5 mm. Diameter 3·25 mm. 148 segments.

Colour pale pink when alive; pale brown with greyish clitellum in ethyl alcohol.

Clitellum xiii–xvii; complete on xiv–xvi, dorsal and lateral on xiii and xvii.

Prostomium prolobous.

Chaetae 8/segment; ab=bc; dd>aa>cd>ab.



FIGS. 89–91. *Octochaetus pelorus* n.sp.
89. Ventral aspect, segments xii–xx
90. Dissection from dorsal aspect, segments i–xxii
91. Right anterior spermatheca, medial aspect

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Prostatic pores on xvii, xix, on low rounded papillae slightly lateral to chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, close together near the ventral mid line, anterior to the chaetae.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Tubercula pubertatis absent.

No specially thickened septa.

Pharynx in i–iv; dorsal and lateral surfaces covered by masses of salivary gland tissue. Proventriculus in v–vi, thin walled. Gizzard in vii, long, thick walled. Oesophagus widely dilated in ½xiv–xvi, not divided into separate glands in each segment. Intestine commences in xviii.

Dorsal blood vessel paired posterior to x/xi. Unpaired supra-intestinal vessel in x–xiii. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii; those of ix and x sac-like, those of xi and xii racemose. Prostates tubular, convoluted; originate in xvii, xix, but those of xvii extend through xvii–xvi and those of xix through xix–xxi. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; conical sac with wide duct to exterior; three slender ducts arise from the medial aspect of the spermathecal duct and open distally into small, ovoidal diverticula. (Fig. 91).

Micronephridia commence in ii; compact cluster of tubules on each side of each segment, attached to the peritoneum between chaetae b and c.

Type Locality: Whangamoa Saddle, beside Nelson-Blenheim road; subsoil, fern and scrub; K.E.L., 26/5/54.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 12 specimens. Lee R. valley; topsoil, manuka scrub; K.E.L., 26/5/54; 10 specimens.

Octochaetus ravus n.sp. Figs. 92–94

Length 182 mm. Diameter 7 mm. 172 segments, all except ii biannulate.

Colour pink when alive; white with pale grey clitellum in alcohol.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: aa>bc>cd>ab; dd≫aa.

Prostatic pores on small rounded papillae on xvii, xix, in line with chaeta b.

Male pores on xviii, in seminal grooves, lateral to chaeta b.

Female pores on xiv, antero-medial to chaeta a, one at each end of a transverse, elliptical, lightly pigmented area.

Spermathecal pores at 7/8, 8/9, ventro-lateral, not visible externally.

Tubercula pubertatis small, round, flattened, ventro-lateral pads,

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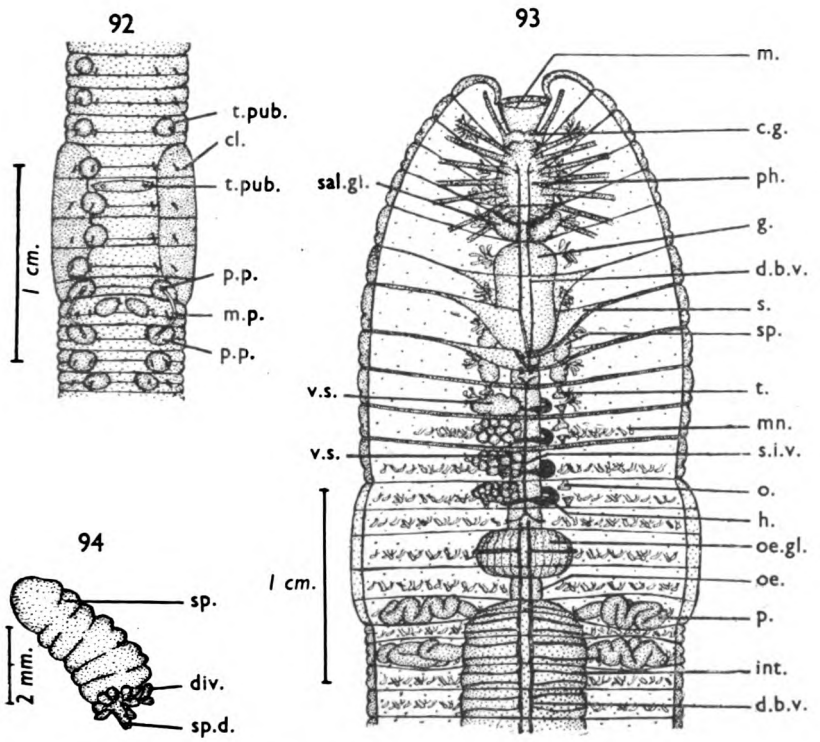

FIGS. 92–94. *Octochaetus ravus* n.sp.
92. Ventral aspect, segments x–xxi
93. Dissection from dorsal aspect, segments i–xxi
94. Right anterior spermatheca, lateral aspect

rather asymmetrically distributed on vii, viii, x, xi, xii, xiii, xiv, xv, xvi, xviii, xx and xxi.

Septa vii/viii to xi/xii thickened.

Pharynx in i–iv. Proventriculus in v, narrow, thin walled. Gizzard in vi, wide, thick walled. Oesophageal glands one pair in xv–½xvi, very large. Intestine commences in xvii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in ix–xiv. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii; those of x sac-like, those of xi, xii racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae absent. Spermathecae in viii, ix; elongate sac, laterally compressed and constricted by irregularly spaced annuli, opening by a short narrow duct; a number of small diverticula open into the spermathecal duct close to its junction with the sac. (Fig. 94).

Micronephridia of ii–x in compact ventro-lateral clusters; posterior to x more evenly distributed over the ventro-lateral and lateral aspects of the peritoneum.

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Type Locality: Ngahere, Westland; subsoil, beech forest; K.E.L., 7/1/52.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 1 specimen.

Octochaetus sylvestris Lee. Fig. 95

1952 *Octochaetus sylvestris* Lee, Trans. roy. Soc. N.Z. 79:560–2.

Length 87 mm. Diameter 4 mm. 154 segments, all segments posterior to vi biannulate.

Colour pink with buff clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: cd>ab; aa=bc>cd; dd≫ aa.

Prostatic pores on small rounded papillae on xvii, xix, slightly lateral to line of chaeta a. Seminal grooves run along a ridge, which joins the two prostatic pores of each side.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

No specially thickened septa.

Proventriculus in v, short, thin walled. Gizzard in vi, large, thick walled. Oesophageal glands in xv. Intestine commences in xviii.

Dorsal blood vessel paired posterior to vii/viii. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, thick, tubular, convoluted. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; large, round, laterally compressed sac with short duct merging into sac; two small tubular diverticula, one antero-medial and one postero-medial, open into spermathecal duct close to base of sac. (Fig. 95).

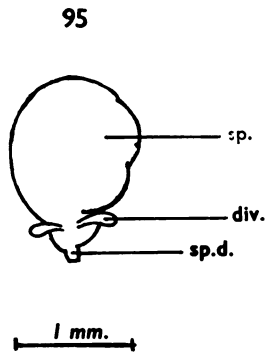

FIG. 95. *Octochaetus sylvestris*. Left posterior spermatheca, medial aspect.

Micronephridia commence in v; in v the tubules form a cushion-like ventro-lateral mass on each side; posterior to v the tubules are in a narrow band across the ventro-lateral and lateral aspects of the peritoneum in each segment.

Type Locality: Wakarara, central Hawke's Bay; topsoil, podocarp forest; K.E.L., 6/7/49.

Type specimen in Soil Bureau collection.

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Localities:

North Island: Same data as type material; 23 specimens. Raukawa Valley, central Hawke's Bay; topsoil, podocarp-broadleaved forest; K.E.L., 6/7/49; 24 specimens.

Octochaetus thomasi Beddard

1892 *Octochaetus thomasi* Beddard, Proc. zool. Soc. Lond., 1892, p. 671.
1894 *Octochaetus thomasi*, Smith, Trans. N.Z. Inst. 26:156, 167–9.
1895 *Octochaetus thomasi*, Beddard, Monograph p. 552.
1900 *Octochaetus thomasi*, Michaelsen, Tierreich 10:319.
1905 *Octochaetus thomasi*, Ude, Z. wiss. Zool. 83.
1935 *Octochaetus thomasi*, Bleakly, Quart. J. micr. Sci. 78:251–70.
1952 *Octochaetus thomasi*, Lee, Trans. roy. Soc. N.Z. 79:537.
1952 *Octochaetus thomasi*, Lee, Trans. roy. Soc. N.Z. 79:558.

Length 140 mm. Diameter 5 mm. 210 segments; all but i–iii triannulate.

Colour pale, almost transparent, brown with dull yellowish clitellum.

Clitellum xiii–xix, complete on xiv–xv, elsewhere dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment: dd>aa>bc>cd>ab.

Prostatic pores on conspicuous papillae on xvii, xix, slightly lateral to chaeta b.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

No septa anterior to iv/v. Septa vi/vii to xii/xiii thickened.

Gizzard in v–vi. Oesophageal glands in xvii. Intestine commences in xix.

Dorsal blood vessel paired posterior to vi/vii, but two vessels joined by a short transverse vessel slightly posterior to each septum. Supra-intestinal vessel commences in vii. Hearts from supra-intestinal vessel and dorsal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Copulatory muscles present. Penial chaetae absent. (Ude (1905) says that penial chaetae are present.) Spermathecae in viii, ix; elongate sac with thick duct; numerous minute diverticula in the shape of granular swellings of the wall of the spermathecal duct, close to its external opening.

Micronephridia present; anterior to first septum (iv/v) they form a single compact cluster on each side, with a slender duct opening into the buccal cavity or the pharynx; posterior to iv/v the tubules are spread across the ventro-lateral and lateral aspects of the peritoneum.

Type Locality: Canterbury Plains; F. E. Beddard, 1892.

Type specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Localities:

South Island: Mt. Somers, N. Canterbury; subsoil, tussock; A. C. S. Wright, 17/1/49; 3 specimens. Opuha, N. Canterbury; topsoil, pasture; A. C. S. Wright, 20/8/51; 7 specimens. Pukerau, N. Canterbury; subsoil, tussock; A. C. S. Wright, 22/8/51; 2 specimens. Inangahua, Westland; topsoil, beech forest; K.E.L., 7/1/52; 1 specimen. Buller Gorge, near Westport; subsoil, beech forest; K.E.L.,

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8/1/52; 2 specimens. Westport, subsoil, pasture; K.E.L., 8/1/52; 1 specimen. Mabelle Bay, Westland; subsoil, broadleaved forest; K.E.L., 8/1/52; 4 specimens. Punakaiki Stm mouth, Westland; topsoil, broadleaved forest; K.E.L., 8/1/52; 1 specimen. Hokitika; topsoil, podocarp forest; K.E.L., 16/1/53; 1 specimen. Marsden, near Hokitika; subsoil, podocarp forest; K.E.L., 8/1/52; 2 specimens. Lake Mahinapua Forest Reserve, near Hokitika; topsoil, podocarp-broadleaved forest; K.E.L., 14/1/53; 2 specimens. Rimu State Forest, near Hokitika; topsoil, moss; K.E.L., 15/1/53; 1 specimen. Rimu State Forest, near Hokitika; topsoil, pine forest; K.E.L., 15/1/53; 1 specimen. Rimu State Forest, near Hokitika; topsoil, manuka scrub; K.E.L., 15/1/53; 6 specimens. Ferguson's Bush, S. of Ross; subsoil, podocarp forest; K.E.L., 9/1/52; 1 specimen. Angus Burn, Western Southland; subsoil, beech forest; A. C. S. Wright, 13/1/49; 1 specimen. Kaituna R., W. Southland; subsoil, beech forest; A. C. S. Wright, 17/1/49; 1 specimen.

Previous Records:

Canterbury Plains: F. E. Beddard, 1892.

Octochaetus tricystis Lee. Fig. 96

1952 *Octochaetus tricystis* Lee, Trans. roy. Soc. N.Z. 79:559–60.

Length 82 mm. Diameter 5 mm. 94 segments.

Colour unpigmented except for purplish clitellum.

Clitellum ½xiii–xvii, dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment: cd=1½ab; aa>bc>cd; dd=2aa.

Prostatic pores on rounded white papillae on xvii, xix, lateral to chaeta b. Seminal grooves run along a prominent white ridge which joins the prostatic papillae of each side.

Male pores in seminal grooves on xviii, lateral to chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

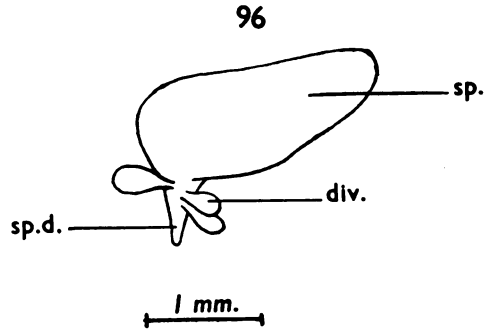

FIG. 96. *Octochaetus tricystis*. Right anterior spermatheca, medial aspect

Septa ix/x to xii/xiii thickened.

Proventriculus in v–vi, wide, thin walled. Gizzard in vii, wide, very thick walled. Oesophageal glands in xv. Intestine commences in xviii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi; clusters of filiform processes. Ovaries in xiii, similar in form to testes. Vesiculae seminales in ix, x, xi, xii; those of ix, x sac-like; those of xi, xii racemose. Prostates in xvii, xix, tubular, very long and convoluted. No penial chaetae nor copulatory muscles.

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Spermathecae in viii, ix; large dorso-ventrally flattened, oval sac, opening by slender duct; three small ovoidal diverticula, without distinct ducts, open, one anteriorly and one posteriorly, into the spermathecal duct close to its junction with the sac. (Fig. 96).

Micronephridia commence in ii and are distributed in a narrow band across the ventro-lateral and lateral aspects of the peritoneum.

Type Locality: R. C. Bruce Memorial Park, Hunterville; subsoil, podocarp forest; K.E.L., 11/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 7 specimens. Mokai Patea, 3,700 ft.; litter mound of dead cedar; A. C. S. Wright, 2/51; 2 specimens. Mokai Patea, 3,800 ft.; topsoil, tussock; A. C. S. Wright, 2/51; 8 specimens.

Genus Perieodrilus Michaelsen

1910 *Perieodrilus* Michaelsen, Mitt. zool. Mus. Hamb. 27:61–2.
1930 *Perieodrilus*, Stephenson, Oligochaeta p. 826.
1937 *Perieodrilus*, Pickford, Monograph p. 89.

Deeply pigmented worms. Chaetae numerous (more than 12) per segment. Clitellum developed over three to eight segments between xiv and xxi. Prostatic pores two pairs, on xvii, xix, on papillae. Seminal grooves present. Male pores one pair, on xviii, in seminal grooves. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9. Nephridiopores in a single lateral series on each side of the body. Gizzard single, in vi or vi–vii, usually well developed, but in *P. plunketi* only visible in sections. Dorsal blood vessel paired; the two vessels are fused at or near the septa in all but one species (*P. plunketi*); four pairs of hearts, the last in xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates two pairs, in xvii, xix, each confined to one segment. Penial chaetae absent. Copulatory muscles present. Spermathecae two pairs, in viii, ix; diverticula in same segment as spermatheca. Nephridial vesicles absent.

Type species: *Perieodrilus lateralis* (Benham)

Number of Species: Four.

Distribution: New Zealand, confined to south-western South Island and Snares Islands. (Fig. 356).

The genus was established by Michaelsen (1910a) for three species described by Benham and included by him in the genus *Plagiochaeta*. *Perieodrilus* is related to *Eodrilus*, from which it differs principally in having the perichaetine arrangement of the chaetae. Like *Eodrilus*, the genus is characterised by the absence of nephridial vesicles.

Key to the Species of Perieodrilus

a$_1$ Vesiculae seminales two pairs, in ix, xii
  b$_1$ Gizzard in vi, large and strong; oesophageal glands absent ... **P. lateralis**
  b$_2$ Gizzard in vi, only visible in sections; oesophageal glands two pairs, in xiv, xv ... **P. plunketi**
a$_2$ Vesiculae seminales four pairs, in ix, x, xi, xii
  c$_1$ Gizzard in vi; oesophageal glands one pair, in xii; spermatheca with numerous small globular diverticula surrounding duct ... **P. ricardi**
  c$_2$ Gizzard in vi–vii; oesophageal glands one pair, in xv; spermatheca with one anterior diverticulum, divided into several lobes ... **P. montanus**

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TABLE 8. Perieodrilus

——	*lateralis*	*montanus*
Length	55 mm.	140–190 mm.
Diameter	5 mm.	8–12 mm.
Segments	100	140–150
Colour	pale grey	brick red; white ring round each segment
Clitellum	xiv–xvii	xiv–xx
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	epilobous	epilobous
Chaetae/segment	c. 24	36–40
Prostatic papillae	small	large
Position of prostatic pores	e	a/b
Position of male pores	e in seminal grooves	a/b in seminal grooves
Position of female pores	anterior to b/c	anterior to a/b
Position of spermathecal pores	7/8, 8/9 e/f	7/8, 8/9 d
Position of nephridiopores	lateral	lateral
Septal thickening	ix/x–xii/xiii	ix/x–xvi/xvii
Proventriculus	v	v
Gizzard	vi	vi–vii
Nature of gizzard	large	large
Oesophageal glands	absent	xv
1st intestinal segment	xx	xviii
Dorsal blood vessel	paired post. to x/xi	paired
Hearts (pairs)	4	4
Origin of hearts	x, xi dorsal b.v. xi, xii supra-intest. v.	dorsal b.vv.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xii racemose	ix, x, xi, xii racemose
Penial chaetae	absent	absent
Copulatory muscles	present	present
Spermathecal diverticula:		
Number	2	1
Form	small, ovoidal	lobulated
Position	1 lateral 1 medial	anterior
Nephridial vesicles	absent	absent

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TABLE 8. Perieodrilus—*continued*

plunketi	*ricardi*
70 mm.	180–290 mm.
1·75 mm.	10–14 mm.
112	c. 170
dark violet with pale chaetal ring	dark purplish brown
xiv–xvi (xvii)	xiv–xx (xxi)
xiv complete; xv-xvi complete except for small ventral area	dorsal and lateral
epilobous	epilobous
16	52–64
small	prominent
b	c
b/c in seminal grooves anterior to b	c in seminal grooves anterior to a/b
7/8, 8/9	7/8, 8/9
lateral to b	g
lateral	lateral
?	viii/ix–xiv/xv
?	v
vi	vi
very small	large
xiv, xv	xii
xx	xviii
paired	paired
4	4
?	dorsal b.v.
x, xi	x, xi
ix, xii	ix, x, xi, xii
racemose	racemose
absent	absent
present	present
2	numerous
tubular	globular
1 anterior	almost surround
1 posterior	duct
absent	absent

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The genus *Perieodrilus* includes four species, three of which are confined to forested country in the extreme south-west of the South Island and the fourth to Snares Islands. Within the genus, differences between species are small (see Table 8), especially in *P. lateralis, P. montanus,* and *P. ricardi,* which are confined to the south-west of the South Island. *P. plunketi,* from Snares Islands, is similar to the South Island species, but whereas those species all have large strong gizzards, *P. plunketi* has a much reduced gizzard, only visible in sections. *P. plunketi* closely resembles *P. lateralis,* from which it can be distinguished only by small anatomical differences.

Perieodrilus lateralis (Benham). Fig. 97

1903 *Plagiochaeta lateralis* Benham, Trans. N.Z. Inst. 35:282–4.
1909 Gen.? (Type *Plagiochaeta lateralis* Benham), Michaelsen, Mem. Indian Mus. 1 (3) :202.
1910 *Perieodrilus lateralis,* Michaelsen, Mitt. zool. Mus. Hamb. 27:63.
1919 *Perieodrilus lateralis,* Benham, Trans. N.Z. Inst. 51:40.
1937 *Perieodrilus lateralis,* Pickford, Monograph p. 89.

Length 55 mm. Diameter 5 mm. 100 segments.

Colour pale greyish with brown clitellum.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae c.24/segment, not arranged in pairs but in ventro-lateral group of five and a dorso-lateral group of 7 on each side of segments, with distinct dorsal, ventral and lateral gaps. Dorsal gap>ventral gap>lateral gap.

Prostatic pores on feebly developed papillae on xvii, xix, in line with chaeta e.

Male pores in seminal grooves on xviii, in line with chaeta e.

Female pores on xiv, anterior to chaetal interval bc.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ef.

Nephridiopores in a single series in line with lateral gap on each side.

Septa ix/x to xii/xiii thickened.

Gizzard in vi, large. Oesophageal glands absent. Intestine commences in xx and in xxi becomes spiral. (Similar to *Hoplochaetina spirilla* Lee.)

Dorsal blood vessel paired posterior to x, but the two vessels fuse at the septa. Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in xii, xiii, from dorsal blood vessel in x, xi.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose; coelomic cavities of x, xi, filled with loosely packed mass of sperms. Prostates in xvii, xix, thick, tubular, convoluted. Penial chaetae absent. Stout copulatory muscles in xviii. Spermathecae in viii, ix; large ovoidal sac with short duct scarcely distinguishable from sac; two small ovoidal diverticula, one lateral and one medial, open by long slender ducts into spermathecal duct. (Fig. 97).

Nephridial vesicles absent.

Type Locality: Forest on shore of Lake Thompson (on track from Lake Te Anau to George Sound); W. B. Benham, 1902. Type (?)

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material in Otago Museum (No. A.56.28); 8 specimens, in good condition.

Localities:

South Island: Stillwater, Caswell Sound; ex leaf mould; R. R. Forster, 11/4/49; 2 specimens. Caswell Sound; in silt on stream bank; R. R. Forster, 14/4/49; 8 specimens.

Perieodrilus montanus (Benham). Fig. 98

1903 *Plagiochaeta montana* Benham, Trans. N.Z. Inst. 35:288–9.
1909 *Plagiochaeta montana,* Michaelsen, Mem. Indian Mus. 1 (3):202.
1913 *Perieodrilus montanus,* Benham and Cameron, Trans. N.Z. Inst. 45:192.
1919 *Perieodrilus montanus,* Benham, Trans. N.Z. Inst. 51:40.
1937 *Perieodrilus montanus,* Pickford, Monograph p. 89.
1952 *Plagiochaeta* (*Perieodrilus*) *montanus,* Lee, Trans. roy. Soc. N.Z. 79:538.

Length 140–190 mm. Diameter 8–12 mm. 140–150 segments.

Colour brick red with white ring around each segment from which chaetae arise.

Clitellum xiv–xx, dorsal and lateral.

Prostomium epilobous.

Chaetae 36–40/segment; not in pairs, dorsal and ventral gaps wider than normal interchaetal gap.

Prostatic pores on large papillae on xvii, xix, in line with chaetal interval ab. Seminal grooves on a prominent ridge, which joins the two prostatic papillae of each side.

Male pores in seminal grooves on xviii, in line with prostatic pores.

Female pores on xiv, in line with chaetal interval ab.

Spermathecal pores at 7/8, 8/9, in line with chaeta d.

Nephridiopores lateral.

Septa ix/x to xvi/xvii thickened.

Gizzard in vi–vii. Oesophageal glands in xv. Intestine commences in xviii, but increases in diameter up to xxiii.

Dorsal blood vessel paired but the two vessels are connected by a commissural vessel slightly anterior to each septum. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xvii, xix, tubular, coiled. Penial chaetae absent. Copulatory muscles in xviii. Spermathecae in viii, ix; large sub-spherical sac with thick duct; single lobulated diverticulum near neck of duct. (Fig. 98).

Nephridial vesicles absent.

Type Locality: Near Lake Thompson on track from Lake Te Anau to George Sound; W. B. Benham, 1903.

Type material in Otago Museum (No. A. 20. 130); 25 specimens and fragments, in good condition.

Localities:

South Island: Upper Stillwater R., Caswell Sound; under bark of rotten log; R. R. Forster, 13/4/49; 6 specimens.

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Perieodrilus plunketi (Benham). Fig. 99

1909 *Plagiochaeta plunketi* Benham, Subant. Is. N.Z. 1:275–6.
1937 *Perieodrilus plunketi,* Pickford, Monograph p. 89.
1950 *Plagiochaeta plunketi,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:29.

Length 70 mm. Diameter 1·75 mm. 112 segments.

Colour dark violet with pale chaetal ring on pre-clitellar segments, clitellum violet grey, narrow line of bluish grey runs along dorsal mid line.

Clitellum xiv–xvi (or xvii); complete on xiv, complete except for a small median ventral area on subsequent segments.

Prostomium epilobous.

Chaetae 16/segment; fairly evenly spaced except for wider dorsal and ventral gaps.

Prostatic pores on papillae on xvii, xix, in position of chaeta b.

Male pores on xviii, between chaetae b and c, not in seminal grooves.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, slightly lateral to line of chaeta b.

Nephridiopores about line of chaeta d or e.

Gizzard visible only in sections, by slight increase in thickness of muscle layer, in vi. Oesophageal glands in xiv, xv. Intestine commences in xx.

Dorsal blood vessel paired. Hearts in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, xix, tubular. Penial chaetae absent. Strong copulatory muscles present. Spermathecae in viii, ix; ovoidal sac with short wide duct; two tubular diverticula, one anterior and one posterior, open into spermathecal duct. (Fig. 99).

Nephridial vesicles not mentioned in Benham's description, but apparently absent.

Type Locality: Snares Islands; W. B. Benham, 1909.

Type material in Otago Museum (No. A.07.7A); 2 fragments only, much hardened, apparently not including the head.

Perieodrilus ricardi (Benham). Fig. 100

1903 *Plagiochaeta ricardi* Benham, Trans. N.Z. Inst. 35:286–8.
1904 *Plagiochaeta ricardi,* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 229.
1909 *Plagiochaeta ricardi,* Michaelsen, Mem. Indian Mus. 1 (3):202.
1910 *Perieodrilus ricardi,* Michaelsen, Mitt. zool. Mus. Hamb. 27:63.
1913 *Perieodrilus ricardi,* Benham and Cameron, Trans. N.Z. Inst. 45:192.
1919 *Perieodrilus ricardi,* Benham, Trans. N.Z. Inst. 51:40.
1937 *Perieodrilus ricardi,* Pickford, Monograph p. 89.
1952 *Plagiochaeta (Perieodrilus) ricardi,* Lee, Trans. roy. Soc. N.Z. 79:538.
1952 *Hoplochaetina ricardi,* Lee, Trans. roy. Soc. N.Z. 79:567.

Length 180–290 mm. Diameter 10–14 mm. c.170 segments.

Colour dark purplish brown (in formalin); dark purple (in ethyl alcohol).

Clitellum xiv–xx (or xxi), dorsal and lateral.

Prostomium epilobous.

Chaetae 52–64/segment; not in pairs, in left and right series separated by dorsal and ventral gaps.

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Prostatic pores on prominent rounded papillae on xvii, xix, in position of chaeta c. Seminal grooves on prominent longitudinal ridge joining the prostatic papillae on each side.

Male pores in seminal grooves on xviii, in position of chaeta c.

Female pores on xiv, anterior to chaetal interval ab.

Spermathecal pores at 7/8, 8/9, in line with seventh from ventral-most chaeta.

Nephridiopores lateral or slightly dorsal of lateral line.

Septa viii/ix to xiv/xv thickened.

Proventriculus in v. Gizzard in vi. Oesophageal glands in xii. Intestine commences in xviii.

Dorsal blood vessel paired but the two vessels are joined slightly anterior to each septum. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Testes and ovaries on ventral aspect of peritoneum, not on septa. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted, somewhat flattened. Penial chaetae absent. Copulatory muscles in xviii. Spermathecae in viii, ix; sub-conical sac with thick duct; nearly complete circle of small, globular diverticula surrounding duct. (Fig. 100).

Type Locality: S.W. corner of Resolution Island, W. Southland; W. B. Benham, 1903.

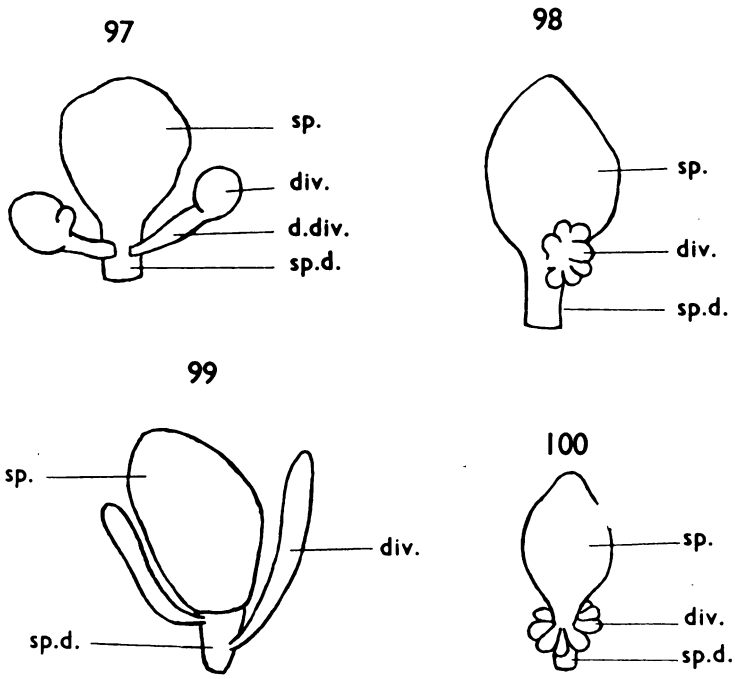

FIG. 97. *Perieodrilus lateralis*. Spermatheca. (After Benham, 1903b)
FIG. 98. *Perieodrilus montanus*. Spermatheca. (After Benham, 1903b)
FIG. 99. *Perieodrilus plunketi*. Spermatheca. (After Benham, 1909)
FIG. 100. *Perieodrilus ricardi*. Spermatheca. (After Benham, 1903b)

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The type material of this species has not been located. A specimen from Otago Museum (A.22.2), named by Benham and in good condition, has been examined by the author.

Genus RHODODRILUS Beddard

1889 *Rhododrilus* Beddard, Proc. zool. Soc. Lond., 1889, p. 380.
1894 *Rhododrilus* (part), Eisen, Mem. Calif. Acad. 2 (3) :22.
1895 *Microscolex* (part), Beddard, Monograph p. 459.
1900 *Rhododrilus* + *Microscolex* (part), Michaelsen, Tierreich 10:143.
1901 *Microscolex* (part), Benham, Trans. N.Z. Inst. 1:276.
1909 *Rhododrilus,* Benham, Subant. Is. N.Z. 1:276.
1909 *Leptodrilus* (Type species: *L. leptomerus* Benham) Benham, Subant. Is. N.Z. 1:276.
1930 *Rhododrilus* + *Leptodrilus,* Stephenson, Oligochaeta p. 825.
1937 *Rhododrilus* + *Leptodrilus,* Pickford, Monograph p. 89.
1952 *Rhododrilus,* Lee, Trans. roy. Soc. N.Z. 79:538.

Worms displaying a great range of colour, size, and habitat. Chaetae eight per segment. Clitellum occasionally not distinguishable; when present developed over three to seven segments between xii and xviii. Prostatic pores one pair, on xvii (in one species on xvi) usually on papillae, papillae sometimes absent, frequently combined with male pores; male pores, if not combined with prostatic pores, one pair, usually on xvii close to prostatic pores, sometimes on anterior portion of xviii, occasionally associated with posterior end of seminal grooves. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores one to five pairs, the last pair anterior to ix/x, ventro-lateral. Nephridiopores in a single series on each side of body, ventro-lateral or lateral. Gizzard single, extending through one or two segments in the region of v–viii, usually strongly developed, occasionally small. Dorsal blood vessel usually unpaired, occasionally paired for all or most of its length; three or four pairs of hearts, the last in xii or xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates one pair, opening to the exterior in xvii (in one species xvi), tubular. Penial chaetae usually present, occasionally absent. Spermathecae one to five pairs, the last in viii or ix; usually one diverticulum on each spermatheca, occasionally more than one, diverticula sometimes projecting through septum into next anterior segment. Meganephridial; nephridial vesicles usually present, of various forms, sometimes absent.

Type species: *Rhododrilus minutus* Beddard.

Number of Species: Thirty.

Distribution: New Zealand, Three Kings Is., Raoul Id. (Kermadec Is.), Campbell Is., Auckland Is., Snares Is. (Fig. 361). One species, *R. queenslandicus,* has been reported from Australia.

The genus was established by Beddard (1889) for a New Zealand species. It is very like the bi-prostatic section of *Microscolex* and was at one time regarded as a subgenus of *Microscolex*. It is distinguished from that genus principally by the degree of development of the gizzard, which is strong and well developed in *Rhododrilus* while in *Microscolex* it is very weakly developed or entirely absent. *Rhododrilus* has previously been regarded as entirely maganephridial, but one species, *R. disparatus* Lee (1952a), has micronephridia as well as megane-

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phridia in the first twenty segments and is thus similar to the micronephridial genus *Leucodrilus*.

Rhododrilus has more species than any other New Zealand genus, and is the most widely distributed New Zealand genus, occurring throughout the region.

KEY TO THE NEW ZEALAND SPECIES OF RHODODRILUS

a_1 Male and prostatc pores combined, on xvi ..... **R. leptomerus**
a_2 Male and prostatic pores on xvii, either combined or more or less closely approximated
  b_1 Spermathecal pores one pair, at 7/8 ..... **R. edulis**
  b_2 Spermathecal pores one pair, at 8/9
    c_1 Septal thickening absent
      d_1 Spermatheca with one lateral diverticulum
        e_1 Penial chaetae absent ..... **R. albidus**
        e_2 Penial chaetae present ..... **R. parvus**
      d_2 Spermatheca with two diverticula, one lateral, one medial ..... **R. insularis**
    c_2 All or some septa between gizzard and prostatic region thickened and strongly muscular
      f_1 Micronephridia as well as meganephridia in first twenty segments ..... **R. disparatus**
      f_2 Meganephridia only in all segments
        g_1 Male and prostatic pores combined on prominent papillae; penial chaetae in sac extending through xvii–xviii ..... **R. intermedius**
        g_2 Male and prostatic pores side by side on low rounded papillae; penial chaetae in sac extending through xvii–xxi ..... **R. besti**
  b_2 Spermathecal pores two or three pairs, at 7/8, 8/9, or 6/7, 7/8, 8/9, or on (vii), viii, ix
    h_1 Gizzard confined to v or in v–vi
      i_1 Some septa between gizzard and prostatic segments thickened and muscular
        j_1 Oesophageal glands absent; vesiculae seminales two pairs, in ix, xii ..... **R. microgaster**
        j_2 Oesophageal glands one pair, in xiv; vesiculae seminales two pairs, in xi, xii ..... **R. macroseptus**
      i_2 Septal thickening absent
        k_1 Last pair of hearts in xii
          l_1 Oesophageal glands absent ..... **R. similis**
          l_2 Oesophageal glands one pair, in xiii
            m_1 Vesiculae seminales two pairs, in xi, xii ..... **R. sutherlandi**
            m_2 Vesiculae seminales three pairs, in ix, xi, xii ..... **R. cockaynei**
        k_2 Last pair of hearts in xiii
          n_1 Spermathecae two pairs, in viii, ix ..... **R. aquaticus**
          n_2 Spermathecae three pairs, in vii, viii, ix ..... **R. kermadecensis**
    h_2 Gizzard confined to vi
      o_1 Last pair of hearts in xii
        p_1 Oesophageal glands absent ..... **R. subtilis**
        p_2 Oesophageal glands one pair, in xiii ..... **R. huttoni**
      o_2 Last pair of hearts in xiii ..... **R. benhami**
  b_3 Spermathecal pores four pairs, at 5/6, 6/7, 7/8, 8/9
    q_1 Oesophageal glands absent
      r_1 Vesiculae seminales two pairs, in xi, xii ..... **R. minutus**
      r_2 Vesiculae seminales four pairs, in ix, x, xi, xii ..... **R. aduncocystis**
    q_2 Oesophageal glands one pair, in xiii
      s_1 Dorsal blood vessel paired; last heart in xii ..... **R. attenuatus**
      s_2 Dorsal blood vessel unpaired, last heart in xiii ..... **R. tetratheca**
a_2 Prostatic pores on xvii, male pores on xviii or at 17/18
  t_1 Gizzard confined to v ..... **R. dobsoni**
  t_2 Gizzard confined to vi
    u_1 Last heart in xii ..... **R. minimus**
    u_2 Last heart in xiii
      v_1 Vesiculae seminales two pairs
        w_1 Vesiculae seminales in ix, xii; spermathecae with five diverticula, two anterior in next segment, three posterior ..... **R. agathis**

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w₂ Vesiculae seminales in x, xii; spermatheca with two diverticula, one lateral, one medial ..... **R. ravus**
w₃ Vesiculae seminales in xi, xii; spermatheca with one anterior diverticulum ..... **R. papaensis**
v₂ Vesiculae seminales three pairs, in x, xi, xii ..... **R. robustus**
v₃ Vesiculae seminales four pairs, in ix, x, xi, xii ..... **R. rosae**

In considering the systematic relationships of the species of *Rhododrilus* their geographical distribution must be taken into account. Examination of the distribution map (Fig. 361) shows that most of the species are found in central districts of the North Island. A few species are confined to the north of the North Island, and a few, of sporadic distribution, are found in the South Island. The remainder of the species are confined to outlying islands. From this pattern it may be inferred that the genus has at some time in the past had a very wide distribution, and the species now found are relics of this ancient, widely distributed genus. It is significant that species of this genus comprise almost the entire fauna of the North Island volcanic area. The more recent Megascolecine genera, which are characteristic of the north of the North Island, are not an important part of the fauna of this area, nor of the country south of the volcanic area.

Within the genus there is a wider variation of morphological characters than is common in other earthworm genera (see Table 8). However, the species appear to form a significant natural group, distinct from the related genera *Microscolex, Eodrilus,* and *Acanthodrilus.*

Benham (1909) proposed a genus *Leptodrilus,* resembling *Rhododrilus* in all respects except that the combined male and prostatic pores are on xvi instead of xvii, and other genital organs are similarly one segment anterior to the positions found in *Rhododrilus.* Variations of one segment in the position of the genital pores are known in other genera, and are not considered sufficient reason to justify the establishment of another genus when in its other characters the species concerned closely resembles species having the typical arrangement of the genital pores. Other examples are *Neodrilus dissimilis* (described in the present work) and *Udeina kinbergi* (see Pickford, 1937, p. 424). *Leptodrilus* is therefore considered as a synonym of *Rhododrilus.*

Four species, *R. disparatus, R. edulis, R. intermedius,* and *R. macroseptus,* have a peculiar nephridial arrangement. In *R. disparatus,* in the first twenty segments, a small ventro-lateral tuft of micronephridia is associated with the meganephridia, while in *R. edulis, R. intermedius,* and *R. macroseptus* each nephridial tubule has a small cluster of tightly wound spiral curves, superficially resembling micronephridia, close to the ventral nerve cord. The nephridia of *R. disparatus* might be regarded as intermediate between those of a typical *Rhododrilus* and a typical *Leucodrilus,* which is wholly micronephridial. The nephridia of the other three species may be regarded as intermediate between those of *R. disparatus* and the typical *Rhododrilus* form. Other significant points regarding these four species are that they are all of large size, similar to the species of *Leucodrilus* and much larger than any other species of *Rhododrilus,*

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and that they are confined to eastern and central districts of the North Island, as are the known species of *Leucodrilus*.

Among the purely meganephridial species of *Rhododrilus* there is no constancy in the form of the nephridial vesicles, and no significance can be attached to this character. Pickford (1937, p. 84) pointed out the wide variation of nephridial vesicles in *Rhododrilus* and the species described in this work confirm her observations. Some species have vesicles, but others have not.

On ecological grounds the species may be divided into four categories, those living in leaf mould, those in topsoil, those in subsoil and those in fresh or brackish water. Two species, *R. cockaynei* and *R. aquaticus,* are found in brackish water. Both species are known from the south of the South Island, and *R. cockaynei* is also found in subantarctic islands. Their ability to tolerate brackish or saline conditions would account for their present distribution. *R. attenuatus* and *R. sutherlandi* are species which inhabit clayey subsoils in North Auckland and they are similar, morphologically, in many respects.

Of a total of 29 species, 14 are confined to central and eastern districts of the North Island. The present distribution of many of these species has been achieved very recently, since a cataclysmic shower of hot volcanic ash covered a large area around Lake Taupo and to the north and east no more than 1,700 years ago, and the soils derived from the ash must have been repopulated from the peripheral areas since that time. The fourteen species include the four (*R. disparatus, R. edulis, R. intermedius, R. macroseptus*) that have the peculiar nephridial arrangement described above. In the remaining ten species it is possible to distinguish groups on morphological characters, but such a grouping bears little relationship to their geographical distribution. For example, in *R. aduncocystis, R. albidus, R. minimus, R. microgaster,* and *R. similis* the male and prostatic ducts of each side open through a common pore on xvii, while in *R. benhami, R. besti, R. papaensis, R. robustus,* and *R. rosae* the ducts open through separate pores. Within these initial groupings it is possible to differentiate the species by the number of pairs of spermathecae, and, although this is satisfactory from the systematic point of view, the groups of species so delineated do not have any relationship to the distribution patterns of the species.

The remaining species of the genus are distributed sporadically on off-shore islands, in Raoul Id. (Kermadec Is.), the South Island, and subantarctic islands. It seems most likely that the present species of *Rhododrilus* are relict forms from an ancient, more widespread and diverse genus, which has been restricted by competition with genera of a more recent origin. The prevalence of *Rhododrilus* in the central North Island is due to the tolerance of those species of the genus from surrounding districts of an environment which does not suit other genera, while the prevalence of *Rhododrilus* in eastern districts of the North Island is probably due to the same unsuitable environment preventing the spread of other, more recent genera (Megascolecinae) into the eastern districts from the northern districts of the North

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TABLE 9. Rhodrilus

——	*aduncocystis*	*agathis*
Length	114 mm.	30 mm.
Diameter	5 mm.	2·5 mm.
Segments	127	49
Colour	dark red brown	deep purple
Clitellum	½xiii–½xviii	xiv–xvi
Extent of clitellum	dorsal and lateral	xv complete; xiv, xvi, dorsal and lateral
Prostomium	epilobous	tanylobous
Prostatic papillae	absent	low, rounded
Position of prostatatic pores	combined	b
Position of male pores	a/b	xviii, in seminal grooves b
Position of female pores	antero-lateral to a	anterior to b
Position of spermathecal pores	5/6, 6/7, 7/8, 8/9 b	8/9 b
Position of nephridiopores	c	c
Septal thickening	viii/ix–xii/xiii	absent
Proventriculus	v	v
Gizzard	vi–vii	vi
Nature of gizzard	large, strong	long, narrow
Oesophageal glands	absent	absent
1st intestinal segment	xvi	xviii
Dorsal blood vessel	unpaired	paired posterior to vi/vii
Hearts (pairs)	3	4
Last heart	xii	xiii
Origin of hearts	supra-intest. b.v.	dorsal b.vv.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii; ix, x sac; xi, xii racemose	ix, xii sac
Prostates	xvii–xxi	xvii
Penial chaetae	xvii	xvii
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	5
Form	stout, tubular, hook-like	pyriform
Position	anterior	2 anterior, 3 posterior
Nephridia	meganephridia	meganephridia
Nephridial vesicles	present	absent

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TABLE 9. Rhododrilus—*continued*

albidus	*aquaticus*	*attenuatus*	*benhami*
95 mm.	35 mm.	79 mm.	57 mm.
2·75 mm.	2 mm.	2 mm.	3 mm.
119	97	145	108
unpigmented	pale brown	unpigmented	pale brown
..	..	xii–xviii	xiv–½xvii
..	..	dorsal and lateral	complete
tanylobous	epilobous	tanylobous	tanylobous
prominent, domed	transverse ridge	small, round, flat	small, rounded
combined a/b	medial to b xvii, post. to prostat. pores b	combined a/b	a/b posterior margin of xvii b
anterior to a 8/9 a/b	anterior to a 7/8, 8/9 b	anterior to a 5/6, 6/7, 7/8, 8/9 a/b	antero-medial to a 7/8, 8/9 a
c	c	c	c
absent	absent	absent	absent
v	absent	absent	v
vi	v	v	vi
long, narrow	small	long	long, strong
xiii	absent	xiii	absent
xviii	xvii	xix	xvi
paired posterior to xii/xiii	unpaired	paired	unpaired
3	4	3	4
xii	xiii	xii	xiii
dorsal b.v.	supra-intest. b.v.	dorsal b.vv.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	ix, xi, xii	xi, xii	x, xi, xii
botryoidal	racemose	racemose	racemose
xvii–xix	xvii–xxiii	xvii–xix	xvii–xxiv
absent	xvii–xxiii	xvii	xvii–xviii
absent	absent	absent	absent
1	1	1	1
small, slender, ovoidal	large, ovoidal	ovoidal	small, tubular
lateral meganephridia rudimentary	lateral meganephridia absent	anterior meganephridia present	lateral meganephridia present

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TABLE 9. Rhododrilus—*continued*

——	*besti*	*cockaynei*
Length	125 mm.	60–150 mm.
Diameter	5 mm.	3·5–4 mm.
Segments	206	72–110
Colour	white	greyish purple
Clitellum	½xiii (xiv)–xvii (xviii)	xiii–xvii
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	epilobous
Prostatic papillae	small, rounded	small, rounded
Position of prostatatic pores	a	a/b
Position of male pores	xvii, medial to prostatic pores	xvii, in line with b
Position of female pores	antero-medial to a	antero-medial to a
Position of spermathecal pores	8/9 a/b	ant. margins of (vii) viii, ix, b
Position of nephridiopores	c	b
Septal thickening	vii/viii–xii/xiii	absent
Proventriculus	absent	absent
Gizzard	v–vi	v
Nature of gizzard	large, strong	very small
Oesophageal glands	absent	xiii
1st intestinal segment	xvii	xviii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	4	3
Last heart	xiii	xii
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	ix, xi, xii racemose
Prostates	xvii–xxiv	xvii–xxi
Penial chaetae	xvii–xxi	xvii–xx
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	1
Form	long, tubular, coiled	curved, cylindrical
Position	lateral	lateral
Nephridia	meganephridia	meganephridia
Nephridial vesicles	?	absent

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TABLE 9. Rhododrilus—*continued*

disparatus	*dobsoni*	*edulis*	*huttoni*
197 mm.	88 mm.	275–285 mm.	90–125 mm.
6 mm.	2·5 mm.	13 mm.	2·5 mm.
203	123	c. 300	130–136
sienna brown	grey	greyish red	pink
½xiii–xviii	½xiii–xvi	xiii–xviii	xiv–xvii
dorsal and lateral	complete except for ventral area on xvi	dorsal and lateral	dorsal and lateral
epilobous	prolobous	epilobous	epilobous
prominent, domed	absent	low, rounded	small, rounded
combined a/b	medial to a anterior margin of xviii, a	a/b xvii, close to prostatic pores	a xvii, close to prostatic pores
anterior to a 8/9	anterior to a 7/8, 8/9	anterior to a 7/8	anterior to a 7/8, 8/9
b	a	b	b
c	c	c	c
vii/viii–xii/xiii	vii/viii–xii/xiii (slight)	vii/viii–xii/xiii	vi/vii–xii/xiii
v	part v	absent	v
vi	part v	v	vi
large, strong	short, narrow	large, strong	long
absent	xv, xvi	absent	xiii
xvi	xviii	xvii	xviii
unpaired	unpaired	unpaired	unpaired
4	3	4	3
xiii	xii	xiii	xii
supra-intest. b.v.	dorsal b.v.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	ix, xii	xi, xii	xi, xii
botryoidal	racemose	botryoidal	racemose
xvii–xxvii	xvii	xvii–xxi	xvii–xxv
xvii–xxiv	absent	xvii–xx	xvii–xxiii
absent	absent	present	absent
1	1	1	1
long, semi-circular tubular anterior	small, slender, ovoidal medial	narrow, tubular separate from spermathecal duct	wide, tubular, undulating lateral
ii–xx micronephridia and meganephridia present	meganephridia absent	meganephridia, convoluted ventrally present	meganephridia absent

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TABLE 9. Rhododrilus—*continued*

——	*insularis*	*intermedius*
Length	20 mm.	228 mm.
Diameter	2 mm.	10·5 mm.
Segments	93	175
Colour	reddish purple	brown
Clitellum	xiv–xvi	xii–xviii
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	epilobous	epilobous
Prostatic papillae	elliptical	prominent, conical
Position of prostatic pores	combined	combined
Position of male pores	b	a/b
Position of female pores	antero-medial to a	antero-lateral to a
Position of spermathecal pores	8/9 b	8/9 b
Position of nephridiopores	c	c
Septal thickening	absent	vi/vii slightly, vii/vi i–xiii/xiv
Proventriculus	v	v
Gizzard	vi–vii	vi
Nature of gizzard	narrow, strong	wide, strong
Oesophageal glands	absent	absent
1st intestinal segment	xviii	xvii
Dorsal blood vessel	paired	unpaired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	supra-intest. b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	xi, xii botryoidal
Prostates	xvii	xvii–xxi
Penial chaetae	absent	xvii–xviii
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	2	1
Form	long, tubular	long, tubular
Position	1 lateral, straight 1 medial, curved	lateral
Nephridia	meganephridia	meganephridia, convoluted ventrally
Nephridial vesicles	present	present

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TABLE 9. Rhododrilus—*continued*

kermadecensis	*leptomerus*	*macroseptus*	*microgaster*
65 mm.	50–85 mm.	386 mm.	112 mm.
1·75 mm.	2–2·75 mm.	11 mm.	8 mm.
108	45–122	236	107
pink	unpigmented	pale pink	very dark green
xiii–xviii	xiii–xvi	½xiii–½xviii	xiv–xvii
dorsal and lateral	complete	complete	complete
epilobous	epilobous	prolobous	epilobous
wide, rounded	small, rounded	prominent, conical	low, rounded
male, prostatic and penial chaetal pores all open on papillae on xvii, in line b	combined on xvi, b	combined a/b	combined a
antero-medial to a	medial to a	antero-lateral to a	antero-medial to a
6/7, 7/8, 8/9 a/b	7/8 b	7/8, 8/9 b	7/8, 8/9 medial to a
c	c	c	c
absent	absent	vi/vii–xiv/xv	viii/ix–xiv/xv
absent	v	absent	absent
v	vi	v–vi	v
?	?	strong	small, slender
xiii, xiv	xii, xiii	xiv	absent
xviii	xv	xvi	xvi
unpaired	unpaired	unpaired	unpaired
3	2	4	4
xiii	xi	xiii	xiii
dorsal b.v.	dorsal b.v.	supra-intest. b.v.	supra-intest. b.v.
x, xi	x, xi	x, xi	x. xi
ix, xi, xii	viii, x, xi	xi, xii	ix, xii
racemose	botryoidal	racemose	botryoidal
xvii–xxii	xvi–xx–xvi	xvii–xx	xvii–xviii
xvii–xxi	present	xvii	xvii
absent	absent	absent	absent
1	1	1	1
long, cylindrical curved	large, cylindrical	irregular	small, globular
lateral	anterior	lateral	medial
meganephridia	meganephridia	meganephridia with ventral convolutions	meganephridia
?	?	present	present

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TABLE 9. Rhododrilus—*continued*

——	*minimus*	*minutus*
Length	54 mm.	65 mm.
Diameter	2 mm.	1·5–2 mm.
Segments	118	100
Colour	unpigmented	colourless
Clitellum	..	xiv-xvii
Extent of clitellum	..	dorsal and lateral
Prostomium	tanylobous	epilobous
Prostatic papillae	small, rounded	low, rounded
Position of prostatic pores	a/b	very close together on xvii b
Position of male pores	anterior margin of xviii, in line with prost. pores	
Position of female pores	anterior to a	anterior to a
Position of spermathecal pores	5/6, 6/7, 7/8, 8/9 ventro-lateral	5/6, 6/7, 7/8, 8/9 ventro-lateral
Position of nephridiopores	c	b
Septal thickening	absent	vi/vii–xi/xii
Proventriculus	v	absent
Gizzard	vi	v
Nature of gizzard	long, strong	?
Oesophageal glands	absent	absent
1st intestinal segment	xvi	xvi
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	3
Last heart	xii	xii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii botryoidal	xi, xii botryoidal
Prostates	xvii–xxii	xvii–xxiv
Penial chaetae	xvii	xvii–xxiv
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	1
Form	small, cylindrical	narrow, tubular
Position	lateral	lateral
Nephridia	meganephridia	meganephridia
Nephridial vesicles	present	absent

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TABLE 9. Rhododrilus—*continued*

papaensis	*parvus*	*ravus*	*robustus*
126 mm.	55–65 mm.	32·5 mm.	55 mm
4 mm.	2–3 mm.	3·25 mm.	3·5 mm.
194	120	96	105
yellowish brown	colourless	bluish grey	pale pink
xiii–xvii	xiv–xvii	xiv–$\frac{1}{3}$xvii	xiii–xvii
complete except for small area on xvii	dorsal and lateral	dorsal and lateral	complete
proepilobous	?	epilobous	tanylobous
small, rounded	small, rounded	broad, flat	absent
a/b anterior on xviii, at end of seminal grooves	combined b	b anterior on xviii, in line with prostatic pores	a anterior on xviii a
antero-medial to a 7/8, 8/9 a/b	ventro-lateral 8/9 b	anterior to b 8/9 b	anterior to a 4/5, 5/6, 6/7, 7/8, 8/9 a/b
c	b	c	c
vi/vii–xii/xiii	absent	absent	absent
v	?	v	v
vi	?	vi	vi
large, strong	large, strong	small, strong	long, strong
absent	viii, ix	absent	absent
xvi	xvi	xviii	xvi
unpaired	unpaired	paired	unpaired
4	?	4	4
xiii	?	xiii	xiii
dorsal b.v.	?	supra-intest. b.v.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	xi, xii	x, xii	x, xi, xii
botryoidal	racemose	botryoidal	racemose
xvii–xxi	xvii–xxiii	xvii	xvii–xxiii
xvii	xvii–xxiv	absent	xvii
absent	absent	absent	absent
1 long, cylindrical anterior	1 large, tubular lateral	2 1 cylindrical 1 pyriform 1 medial 1 lateral	Spermatheca consists of two lobes: lateral, thick walled, and medial, thin walled, both opening into muscular atrium
meganephridia present	meganephridia absent	meganephridia "J"-shaped Acanthodrilus type	meganephridia present

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TABLE 9. Rhododrilus—*continued*

	rosae	*similis*
Length	89 mm.	75–165 mm.
Diameter	4 mm.	3–5 mm.
Segments	131	150–200
Colour	purplish red	white
Clitellum	xiv–xvi	½xiii–xvii
Extent of clitellum	complete	dorsal and lateral
Prostomium	tanylobous	epilobous
Prostatic papillae	prominent	small, rounded
Position of prostatic pores	b	combined
	17/18 at end sem. grooves	a/b
Position of male pores	b	
Position of female pores	anterior to a	anterior to a
Position of spermathecal pores	8/9 b	7/8, 8/9 medial to b
Position of nephridiopores	c	c
Septal thickening	absent	absent
Proventriculus	v	absent
Gizzard	vi	v
Nature of gizzard	short, wide	strong
Oesophageal glands	absent	absent
1st intestinal segment	xviii	xvi
Dorsal blood vessel	paired, but fusing at septa	unpaired
Hearts (pairs)	3	3
Last heart	xiii	xii
Origin of hearts	supra-intest. b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii racemose	xi, xii racemose
Prostates	xvii	xvii–xxi (xxii)
Penial chaetae	absent	xvii
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	5	1
Form	small, reniform	long, curved
Position	surround duct	lateral
Nephridia	meganephridia	meganephridia
Nephridial vesicles	present	present

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TABLE 9. Rhododrilus—*continued*

subtilis	*sutherlandi*	*tetratheca*
26·5 mm.	143 mm.	115 mm.
1·5 mm.	2 mm.	4 mm.
102	c. 150	227
pale pink	colourless	pale brown
½xiii–xvii	xiii–xvii	½xiii–xvii
dorsal and lateral	dorsal and lateral	dorsal and lateral
tanylobous	epilobous	epilobous
small, conical	prominent, rounded	small, rounded
combined a/b	combined a/b	combined a/b
antero-medial to b	antero-medial to b	antero-lateral to a
6/7, 7/8, 8/9 b	7/8, 8/9 b	5/6, 6/7, 7/8, 8/9 b
c	c	c
absent	absent	v/vi–xi/xii
v	absent	absent
vi	v	v
long, strong	strong	wide
absent	xiii	xiii
xvi	xvii	xvii
unpaired	unpaired	unpaired
3	**3**	**4**
xii	xii	xiii
dorsal b.v.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii
botryoidal	botryoidal	racemose
xvii–xxii	xvii–xx	xvii–xxiv
xvii–xviii	xvii	xvii–xxiv
absent	absent	absent
1	**1**	**1**
short, tubular	ovoidal	straight, tubular
lateral	anterior	medial
meganephridia	meganephridia	meganephridia
present	present	present

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Island, in which they are dominant. Recent climatic changes in the South Island, where *Rhododrilus* is found only sporadically, have probably modified the distribution pattern of any representatives of the genus that may have previously inhabited the Island.

Rhododrilus aduncocystis Lee. Figs. 101–103

1952 *Rhododrilus aduncocystis* Lee, Trans. roy. Soc. N.Z. 79:552–3.

Length 114 mm. Diameter 5 mm. 127 segments.

Colour dark red brown, pale ventrally posterior to clitellum, clitellum buff.

Clitellum ½xiii–½xviii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: aa>bc>cd>ab; dd≫aa.

Male and prostatic pores on xvii; combined; each in a small, round brown area, in line with chaetal interval ab.

Female pores on xiv; anterior and slightly lateral to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, in line with chaeta b.

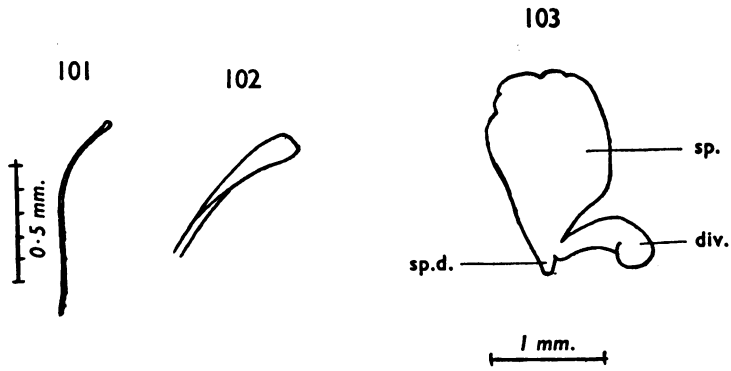
Nephridiopores in line with chaeta c.

Septa viii/ix–xii/xiii thickened.

Proventriculus in v, short, thin walled. Gizzard in vi–vii, large, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in x–xii. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii; those of ix, x sac-like and compact, those of xi, xii racemose. Prostates in xvii–xxi, extending straight back to xxi, terminating in a coiled portion. Penial chaetae in xvii; gently curved shaft, slightly recurved and spatulate distally (Figs. 101, 102). Spermathecae in vi, vii, viii, ix; those of vii, viii, ix with irregularly oval, antero-posteriorly flattened sac and a stout diverticulum curved in a hook-like form, opening into the anterior aspect of the spermathecal duct (Fig. 103): those of vi smaller, with a small, slender, tubular, semi-transparent sac,



FIGS. 101–103. *Rhododrilus aduncocystis*
101. Penial chaeta
102. Tip of penial chaeta
103. Right posterior spermatheca, posterior aspect

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and a diverticulum similar to those of the more posterior spermathecae but smaller.

Nephridia with vesicles.

Type Locality: Near Whatawhata, W. Waikato; topsoil, bracken fern; K.E.L., 18/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Waipa R. bank, W. Waikato; subsoil, broadleaved forest; K.E.L., 17/5/50; 9 specimens. Near Whatawhata, W. Waikato; topsoil, bracken fern; K.E.L., 18/5/50; 3 specimens. Near Whatawhata; topsoil, broadleaved forest; K.E.L., 18/5/50; 4 specimens. Pukemiro, W. Waikato; topsoil, bracken fern; K.E.L., 20/5/50; 3 specimens. Pukemiro, W. Waikato; topsoil, broadleaved forest; K.E.L., 20/5/50; 3 specimens. Te Rau-a-Moa, W. Waikato; topsoil, broadleaved forest; K.E.L., 21/5/50; 1 specimen. Lower Waihaha R., W. Taupo; topsoil, broadleaved forest; A. C. S. Wright, Jan. 1951; 10 specimens. Mangakara R., W. Taupo; topsoil, manuka scrub; A. C. S. Wright, Jan. 1951; 8 specimens. Mangakara R., W. Taupo; topsoil, podocarp forest; A. C. S. Wright, Jan. 1951; 4 specimens. Oruapuraho R., W. Taupo; topsoil, *Dracophyllum* scrub; A. C. S. Wright, Jan. 1951; 1 specimen. Upper Waihaha R., W. Taupo; topsoil, rough pasture; A. C. S. Wright, Jan. 1951; 2 specimens. Waikite Valley, near Rotorua; R. L. Nielson, 22/6/53; 2 specimens.

Rhododrilus agathis n.sp. Figs. 104–107

Length 30 mm. Diameter 2·5 mm. 49 segments.

Colour deep purple with pale greyish buff clitellum.

Clitellum xiv–xvi; complete on xv, dorsal and lateral on xiv and xvi. Prostomium tanylobous.

Chaetae 8/segment: dd>cd>bc>ab>aa.

Prostatic pores on xvii, on low rounded papillae, in line with chaeta b. Seminal grooves pass back across the papillae to the anterior margin of xviii.

Male pores at posterior ends of seminal grooves, at extreme anterior margin of xviii.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

There are no tubercula pubertatis.

No specially thickened septa.

Pharynx in i–iv, covered by salivary glands. Proventriculus in v, short, narrow, thin walled. Gizzard in vi, narrow, elongate. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired posterior to vi/vii. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi, with very large funnels. Ovaries in xiii. Prostates in xvii, very long, tubular, coiled, and convoluted. Penial chaetae in xvii; small, slightly curved, unornamented spines, with rounded tip (Fig. 106). Spermathecae in ix; large irregularly ovoid sac with short narrow duct; five small pyriform diverticula open into the spermathecal duct close to its junction with the sac, two of the diverticula are anterior and project through septum viii/ix into viii and three are posterior and are in ix. (Fig. 107).

Nephridia small and slender, without vesicles.

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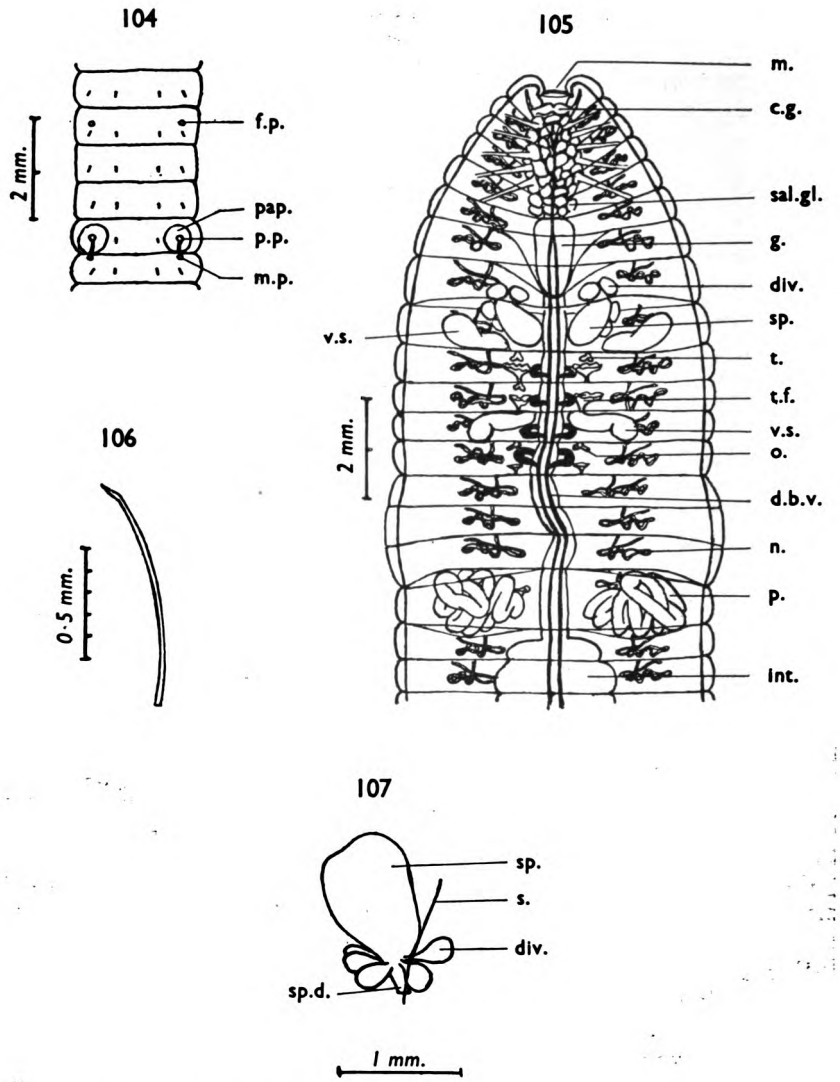

FIGS. 104–107. *Rhododrilus agathis* n.sp.
104. Ventral aspect, segments xiii–xviii
105. Dissection from dorsal aspect, segments i–xix
106. Penial chaeta
107. Right spermatheca, lateral aspect

Type Locality: Waipoua Kauri Forest; ex leaf mould; W. R. McGregor, Jan. 1952.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 4 specimens.

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Rhododrilus albidus Lee. Fig. 108

1952 *Rhododrilus albidus* Lee, Trans. roy. Soc. N.Z. 79:539–40.

Length 95 mm. Diameter 2·75 mm. 119 segments; all segments biannulate except i and ii.

Colour unpigmented, with semi-transparent body wall.

Clitellum not obvious.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; dd>bc>aa>ab.

Male and prostatic pores combined, on prominent brownish dome-like papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 8/9, in line with chaetal interval ab.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Proventriculus in v, short, thin walled. Gizzard in vi, elongate thin walled. Oesophageal glands in xiii. Intestine commences in xviii.

Dorsal blood vessel paired posterior to xii/xiii. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, consisting of small round masses of vesicular tissue attached to a thin lamina. Prostates in xvii–xix, tubular, convoluted. Penial chaetae absent. Spermathecae in ix; flat disc-like sac opening by narrow duct; small, rather slender, ovoidal diverticulum opening by short slender duct into lateral aspect of spermathecal duct. (Fig. 108).

Nephridia very small and convoluted, with rudimentary vesicles.

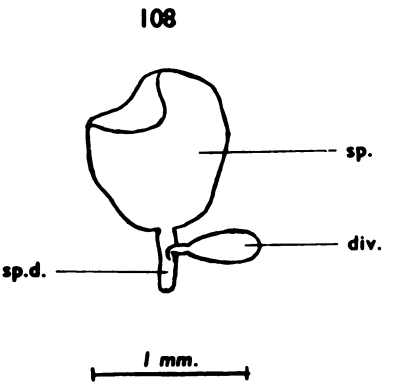

FIG. 108. *Rhododrilus albidus*. Left spermatheca, lateral aspect

Type Locality: Ball's Clearing Forest Reserve, Puketitiri, Hawke's Bay; topsoil, tussock; K.E.L., 5/7/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Horopito; ex leaf mould; R. R. Forster, 22/12/48; 1 specimen. Chateau Tongariro; ex moss; R. R. Forster, 18/12/48; 4 specimens. Ball's Clearing, Puketitiri; topsoil, beech forest; K.E.L., 5/7/49; 6 specimens. Same data; K.E.L., 29/11/49; 6 specimens. Ball's Clearing, Puketitiri; topsoil, tussock; K.E.L., 5/7/49; 14 specimens. Same data; K.E.L., 29/11/49; 8 specimens. Ball's Clearing, Puketitiri; topsoil, pasture grasses; K.E.L., 29/11/49; 3 specimens. Puketitiri; topsoil, pasture grasses; K.E.L., 5/7/49; 6 specimens. Raukawa Valley, Hawke's Bay; topsoil, broadleaved forest; K.E.L., 6/7/49; 3 specimens. Same data; K.E.L., 1/12/49; 1 specimen. Okaihau Rd., Hawke's Bay; topsoil, pasture; K.E.L., 30/11/49; 4 specimens. Waimarama Ra., Hawke's Bay; topsoil, broadleaved forest; K.E.L., 30/11/49; 3 specimens. Wakarara, Hawke's Bay; topsoil, broadleaved forest; K.E.L., 1/12/49; 4 specimens. Blowhard Ra., W. Hawke's Bay; topsoil, pasture grasses and manuka scrub; K.E.L., 11/10/50; 16 specimens. Blowhard Ra., W. Hawke's Bay; topsoil, broadleaved forest; K.E.L., 11/10/50; 6 specimens. Tarua Rau Hill Summit, beside Napier-Taihape road; topsoil, danthonia tussock; K.E.L., 11/10/50; 5 specimens. Waiouru; top-

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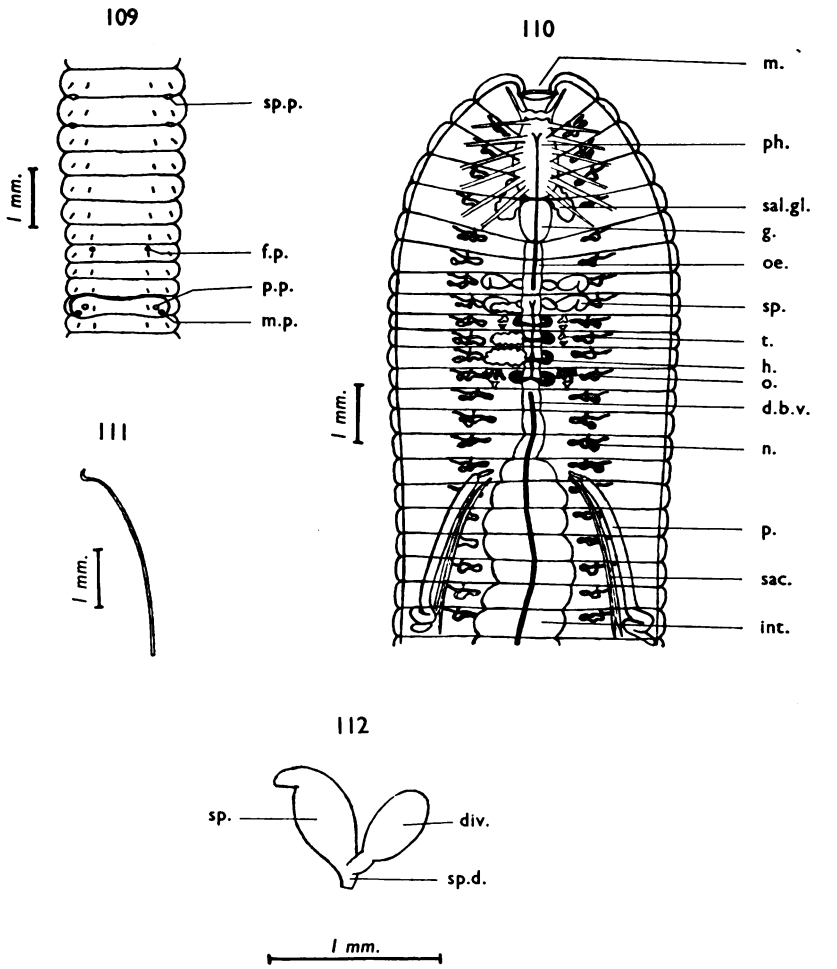
soil, *Libocedrus* forest; A. C. S. Wright, 25/9/50; 8 specimens. Waiouru; topsoil, *Danthonia-Festuca* tussock; A. C. S. Wright, 25/9/50; 8 specimens. Waiouru Military Camp; *Danthonia-Festuca* tussock; K.E.L., 10/3/53; 67 specimens. Waiouru Military Camp; topsoil, forest; K.E.L., 11/3/53; 2 specimens. Waiouru Military Camp; topsoil, tussock; R. H. Thornton, 25/9/53; 5 specimens. Mokai Patea, Ruahine Ra. 3,400 ft.; topsoil, pasture grasses; A. C. S. Wright, 2/51; 2 specimens. 11 miles north of Tolaga Bay; topsoil, broadleaved forest; K.E.L., 9/1/51; 4 specimens. Blairlogie, Wairarapa; topsoil, broadleaved forest; K.E.L., 17/4/50; 5 specimens. Pirinoa, Wairarapa; topsoil, pasture; K.E.L., 30/8/49; 3 specimens. Waiorongomai, Wairarapa; topsoil, beech forest; K.E.L., 19/4/50; 4 specimens.



FIGS. 109–112. *Rhododrilus aquaticus* n.sp.
109. Ventral aspect, segments vii–xviii
110. Dissection from dorsal aspect, segments i–xxiii
111. Penial chaeta
112. Left posterior spermatheca, posterior aspect

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Rhododrilus aquaticus n.sp. Figs. 109–112

Length 35 mm. Diameter 2 mm. 97 segments.

Colour pale brown (in ethyl alcohol).

Clitellum not developed.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc>cd>ab.

Prostatic pores and male pores on xvii; the pores are on a transverse ventral ridge, the prostatic pores slightly medial to the position of chaeta b and the male pores posterior to the prostatic pores in line with chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Tubercula pubertatis absent.

No specially thickened septa.

Pharynx in i–iv. Gizzard in v, small. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii. Testes in x, xi, small and compact. Ovaries in xiii, large. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii–xxiii; long, straight tubular organs, with a short terminal coiled portion in xxiii. Penial chaetae in xvii–xxiii; long, slender, gently curved shaft, sharply curved distally at right angles to the plane of curvature of the shaft, and terminating in a sharp point (Fig. 111). Spermathecae in viii, ix; roughly ovoidal sac with distal end prolonged into a curved, tubular process, opening by a short wide duct; ovoidal diverticulum, slightly smaller than sac, opens by wide duct into lateral aspect of spermathecal duct. (Fig. 112).

Nephridial vesicles absent.

Type Locality: Caswell Sound, W. Southland; under stones in freshwater stream; R. R. Forster, 18/4/49.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 11 specimens. Caswell Sound; under stones in brackish water; R. R. Forster, 16/4/49; 22 specimens.

Rhododrilus attenuatus Lee. Figs. 113, 114

1952 *Rhododrilus attenuatus* Lee, Trans. roy. Soc. N.Z. 79:549–50.

Length 79 mm. Diameter 2 mm. 145 segments.

Colour unpigmented except for clitellar segments (xii–xviii) which are pale brownish.

Clitellum xii–xviii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=dd; aa>bc>ab.

Combined prostatic and male pores on small, round, flattened papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, in line with chaetal interval ab.

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Nephridiopores in line with chaeta c.

No specially thickened septa.

Gizzard in v. Oesophageal glands in xiii. Intestine commences in xix; in xix its diameter is almost the same as that of the oesophagus, but the diameter increases until in xxii it is almost twice the diameter of the oesophagus.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xix, tubular, convoluted. Penial chaetae in xvii; long, slender, gently curved shaft with recurved, flattened tip (Fig. 113). Spermathecae in vi, vii, viii, ix; spheroidal sac with short duct; ovoidal diverticulum in next anterior segment, opening by short duct through septum into anterior aspect of spermathecal duct. (Fig. 114).

Nephridia with small vesicles.

Type Locality: Near Mangonui, North Auckland; subsoil, scrub; K.E.L., 24/3/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 3 specimens. Victoria Valley, near Kaitaia; topsoil, broadleaved forest; K.E.L., 23/3/49; 4 specimens. Mangamuku Ra., near Kaitaia; subsoil, podocarp-broadleaved forest; K.E.L., 23/3/49; 1 specimen. Te Kao; subsoil, fern and scrub; K.E.L., 25/3/49; 4 specimens. Te Kao; topsoil, scrub; K.E.L., 25/3/49; 12 specimens.

Rhododrilus benhami Lee. Figs. 115, 116

1952 *Rhododrilus benhami* Lee, Trans. roy. Soc. N.Z. 79:548–9.

Length 57 mm. Diameter 3 mm. 108 segments.

Colour pale brown.

Clitellum xiv–½xvii, complete.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc>ab; dd≫aa.

Prostatic pores on small rounded papillae on xvii, in line with chaetal interval ab.

Male pores on extreme posterior margin of xvii, in line with chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Proventriculus in v, short, narrow, thin walled. Gizzard in vi, long, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii, racemose. Prostates in xvii–xxiv, long, tubular organs, extending straight back through segments. Penial chaetae in xvii–xviii; long slender shaft bent fairly sharply about half way along its length, recurved near distal end, with flattened tip terminating in point (Fig.

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115). Spermathecae in viii, ix; long tubular sac opening by narrow duct; small tubular diverticulum lies lateral to spermathecal sac and opens by short narrow duct into lateral aspect of spermathecal duct. (Fig. 116).

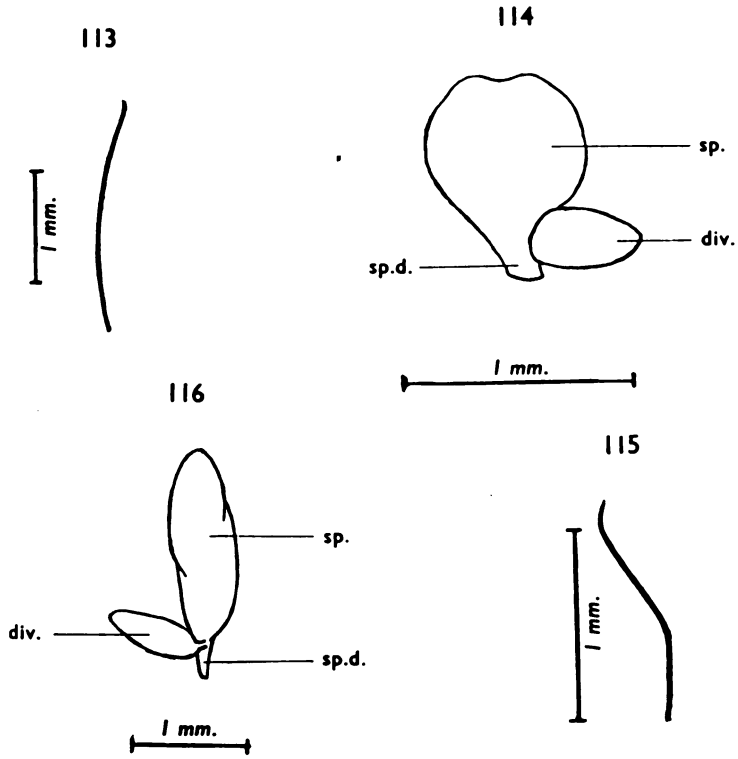
Nephridial vesicles present.

Type Locality: Near Nukumaru, Wanganui district; topsoil, broadleaved forest; K.E.L., 11/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 11 specimens. Mt. Messenger, north Taranaki; topsoil, broadleaved forest; K.E.L., 11/5/50; 2 specimens. Near Whatawhata, W. Waikato; topsoil, broadleaved forest; K.E.L., 18/5/50; 10 specimens. Pukemiro, W. Waikato; topsoil, bracken; K.E.L., 20/5/50; 3 specimens. Te Akau, W. Waikato; topsoil, broadleaved forest; K.E.L., 20/5/50; 1 specimen. 3 miles S. of Raglan on Raglan-Kawhia road; topsoil, broadleaved forest; K.E.L., 20/5/50; 4 specimens. Te Mata, near Raglan; topsoil, podocarp-broadleaved forest; K.E.L., 21/5/50; 5 specimens. Moerangi, near Raglan; topsoil, podocarp-broadleaved forest; K.E.L., 21/5/50; 1 specimen. Kawhia Ra., topsoil, podocarp-broadleaved forest; K.E.L., 21/5/50; 1 specimen. Te Rau-a-Moa; topsoil, broadleaved forest; K.E.L., 21/5/50; 1 specimen. Ngaroma, near Arapuni; topsoil, podocarp-broadleaved forest; K.E.L., 25/5/50; 1 specimen. Mairoa, west of Te Kuiti; topsoil, broadleaved forest; K.E.L., 26/5/50; 8 specimens.



FIGS. 113, 114. *Rhododrilus attenuatus*
113. Penial chaeta
114. Right posterior spermatheca, lateral aspect
FIGS. 115, 116. *Rhododrilus benhami*
115. Penial chaeta
116. Right posterior spermatheca anterior aspect

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Rhododrilus besti Benham. Figs. 117, 118.

1904 *Rhododrilus besti* Benham, Proc. zool. Soc. London, 1904 (2), p. 220
1905 *Rhododrilus besti,* Benham, Trans. N.Z. Inst. 37:283.
1906 *Rhododrilus besti,* Benham, Trans. N.Z. Inst. 38:239.
1906 *Rhododrilus besti,* Benham, Trans. N.Z. Inst. 38:251.
1907 *Rhododrilus besti,* Michaelsen, Fauna Südwest-Aust. 1 .(2) :142.
1937 *Rhododrilus besti,* Pickford, Monograph p. 89.
1952 *Rhododrilus besti,* Lee, Trans. roy. Soc. N.Z. 79:539.

Length 125 mm. Diameter 5 mm. 206 segments.

Colour white with red clitellum (alive); white with yellow-brown clitellum in alcohol.

Clitellum ½xiii(xiv)–xvii(xviii), dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; bc=aa>ab; dd>aa.

Prostatic pores on small rounded papillae on xvii, in position of chaeta a.

Male pores on same papillae as prostatic pores, slightly medial to prostatic pores.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 8/9, in line with chaetal interval ab.

Nephridiopores in line with chaeta c.

Septa vii/viii to xii/xiii thickened.

Gizzard in v–vi, large, thick walled. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xxiv, long, tubular, convoluted. Penial chaetae in xvii–xxi, slender, gently curved, with blunt tip curved in opposite direction, flattened and hollowed in a spoon-like form at the tip (Fig. 117). Spermathecae in ix; roughly ovoidal sac with short, wide duct; long tubular diverticulum, spirally coiled at its lower end where it enters the spermathecal duct – lower end of diverticulum muscular though of same diameter as remainder of diverticulum. (Fig. 118).

Type Locality: Ruatahuna, Urewera Country; W. B. Benham, 1905.

Type material in Otago Museum (No. A.43.41); 1 specimen, dissected and cut into fragments.

Previous Records:

North Island: Ruatoki, S. of Whakatane; W. B. Benham, 1906.

Rhododrilus cockaynei Benham. Figs. 119, 120

1905 *Rhododrilus cockayni* Benham, Trans. N.Z. Inst. 37:289.
1907 *Rhododrilus cockayni,* Michaelsen, Fauna Südwest-Aust. 1 (2) :142.
1909 *Rhododrilus cockayni,* Benham, Subant. Is. N.Z. 1:277–8.
1923 *Rhododrilus cockayni,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:220.
1937 *Rhododrilus cockayni,* Pickford, Monograph p. 89.
1950 *Rhododrilus cockayni,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:30.
1952 *Rhododrilus cockayni,* Lee, Trans. roy. Soc. N.Z. 79:539.

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Length 60–150 mm. Diameter 3·5–4 mm. 72–110 segments.

Colour greyish purple with brown clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: aa=bc; dd>aa>cd>ab.

Prostatic pores on papillae on xvii, in line with chaetal interval ab.

Male pores on xvii, in line with chaeta b.

Spermathecal pores at anterior margins of vii, viii, ix (sometimes only two pairs on viii, ix), in line with chaeta b.

Nephridiopores in line with chaeta b.

No specially thickened septa.

Gizzard in v. Oesophageal glands in xiii. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii–xxi, tubular. Penial chaetae in xvii–xx; long, slender shaft, abruptly curved near tip, which is sharply recurved and pointed (Fig. 119). Spermathecae in vii, viii, ix (sometimes in viii, ix); large ovoidal sac with short wide duct; curved, cylindrical diverticulum opens into spermathecal duct. (Fig. 120).

Nephridial vesicles absent.

Type Locality: Campbell Island; W. B. Benham, 1904.

Type material in Otago Museum (No. A.54. 64); 6 specimens, slightly mascerated.

Remarks: Benham (1909) distinguished a variety of this species from Snares Is. He named it *R. cockayni* var. *waterfieldi* and separated it from the typical variety because it had two pairs of spermathecae, in viii, ix instead of three pairs, in vii, viii, ix (but this is sometimes true of the typical variety, viz. Benham 1909, p. 278), and on geographical grounds. Since *R. cockaynei* is euryhaline (see Benham, 1909, p. 278) and is known from a number of subantarctic islands, and I have now recorded it from the South Island of New Zealand, there is no point in separating varieties on geographical grounds. I do not, therefore, recognise the variety.

The specific name has previously been spelt *cockayni,* but, since the species is named after Dr Cockayne, the correct spelling is *cockaynei.*

Localities:

South Island: Allan's Beach, Otago Peninsula; under *Cotuletum* in salt meadow; K. Paviour-Smith, 10/9/53; 7 specimens. Same data; K. Paviour-Smith, 24/9/53; 14 specimens.

Subantarctic Islands: Sandy Bay, Enderby Id.; ex leaf mould; R. K. Dell, 18/3/54; 1 specimen. Freshwater Stm., Sandy Bay, Enderby Id.; ex leaf mould; R. K. Dell, 18/3/54; 1 specimen. Near Derry Castle Reef, Enderby Id.; under stones and logs; R. K. Dell; 17/3/54; 4 specimens. N.W. corner of Enderby Id.; under stones; R. K. Dell, 19/3/54; 1 specimen. Ranui Cove, Auckland Id.; under rocks in intertidal zone; M. L. Leamy, 11/54; 5 specimens.

Previous Records:

Subantarctic Islands: Ewing and Adams Is. of Auckland Group (Benham, 1905). Auckland Islands (records from Benham, 1909): Carnley Harbour, seashore; on plants; Adams Id., Fairchild's garden (*Pleurophyllum* meadow); top of hill above western entrance to Carnley Harbour; Norman Inlet, seashore.

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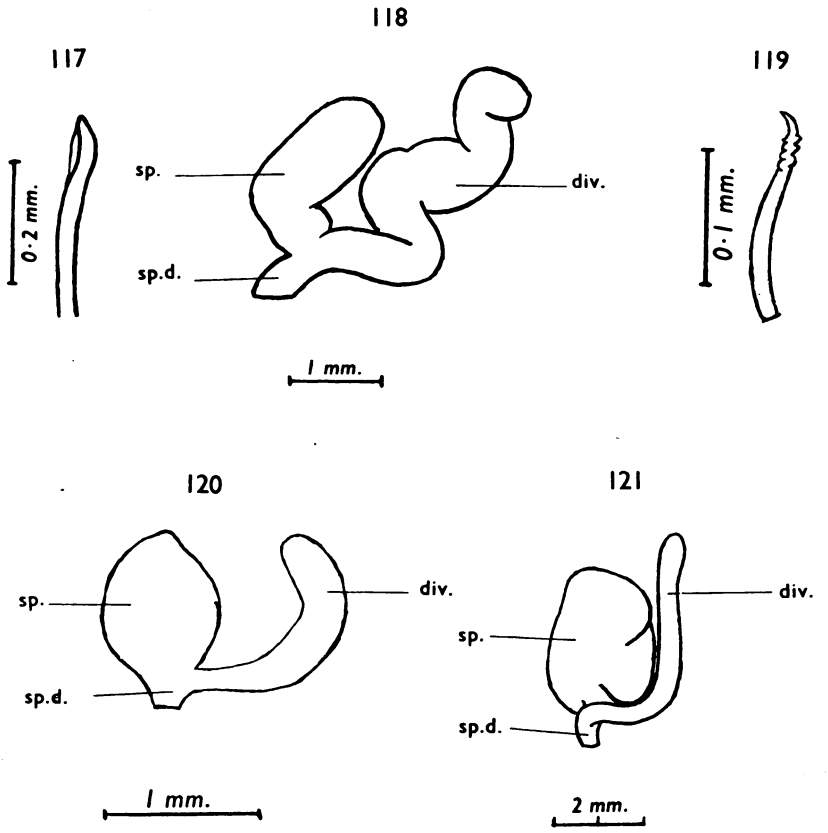
Campbell Island (records of Benham, 1909): Mount Honey; Monument Harbour; sea shore; tussock near shore; under moss, Monument Harbour. Campbell Island (Benham, 1905).
Snares Islands: W. B. Benham, 1909 (type material of var. *waterfieldi*).

Rhododrilus disparatus Lee. Fig. 121

1952 *Rhododrilus disparatus* Lee, Trans. roy. Soc. N.Z. 79:542–4.

Length 197 mm. Diameter 6 mm. 203 segments.
Colour sienna brown with greyish brown clitellum.
Clitellum ½xiii–xviii, dorsal and lateral.
Prostomium epilobous.
Chaetae 8/segment: ab=cd; dd>bc>aa>ab.



Figs. 117, 118. *Rhododrilus besti*
117. Tip of penial chaeta
118. Spermatheca
(Drawings after Benham, 1904b)
Figs. 119, 120. *Rhododrilus cockaynei*
119. Tip of penial chaeta
120. Spermatheca
(Drawings after Benham, 1905c)
Fig. 121. *Rhododrilus disparatus*. Left spermatheca, lateral aspect

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Combined prostatic and male pores on prominent dome-like papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Septa vii/viii to xii/xiii thickened.

Proventriculus in v, wide, thin walled. Gizzard in vi, large, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii, xiii. Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxvii; long tubular organs running almost straight back to xxvi, coiled in xxvi–xxvii. Penial chaetae in sacs, which parallel the prostates through xvii–xxiv, penial chaetae much shorter than sacs; elongate, slightly irregular, gently curved shaft with gently recurved tip terminating in a point. Spermathecae in ix; roughly ovoidal sac with short narrow duct; long tubular diverticulum arises from anterior aspect of spermathecal duct, curves in a semicircle around the base of the sac, terminating in a dorsally directed portion. (Fig. 121).

Nephridia commence in ii; in ii–xx small, coiled, meganephridial tubules open beside chaeta c, but also a small ventro-lateral cluster of micronephridia is found on each side of each segment; posterior to xx the meganephridia are larger and there are no micronephridia. Nephridial vesicles present.

Type Locality: 3 miles S. of Tolaga Bay; topsoil, forest; K.E.L., 23/11/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. 10 miles E. of Otoko; topsoil, broadleaved forest; K.E.L., 24/11/49; 1 specimen.

Rhododrilus dobsoni n.sp. Figs. 122–124

Length 88 mm. Diameter 2·5 mm. 123 segments.

Colour grey with brownish grey clitellum.

Clitellum ½xiii–xvi, complete except for a small posterior median ventral area on xvi.

Prostomium prolobous.

Chaetae 8/segment: ab=cd; dd>aa>bc>ab.

Prostatic pores on xvii, not on papillae, one on each side of an oval, median ventral, darkly pigmented area, medial to chaeta a.

Male pores on extreme anterior margin of xviii, slightly lateral to line of prostatic pores, not in seminal grooves.

Female pores on xiv, slightly anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores in line with chaeta c.

Four unpaired, median ventral, oval tubercula pubertatis, one each at 10/11, 18/19, 19/20, 20/21.

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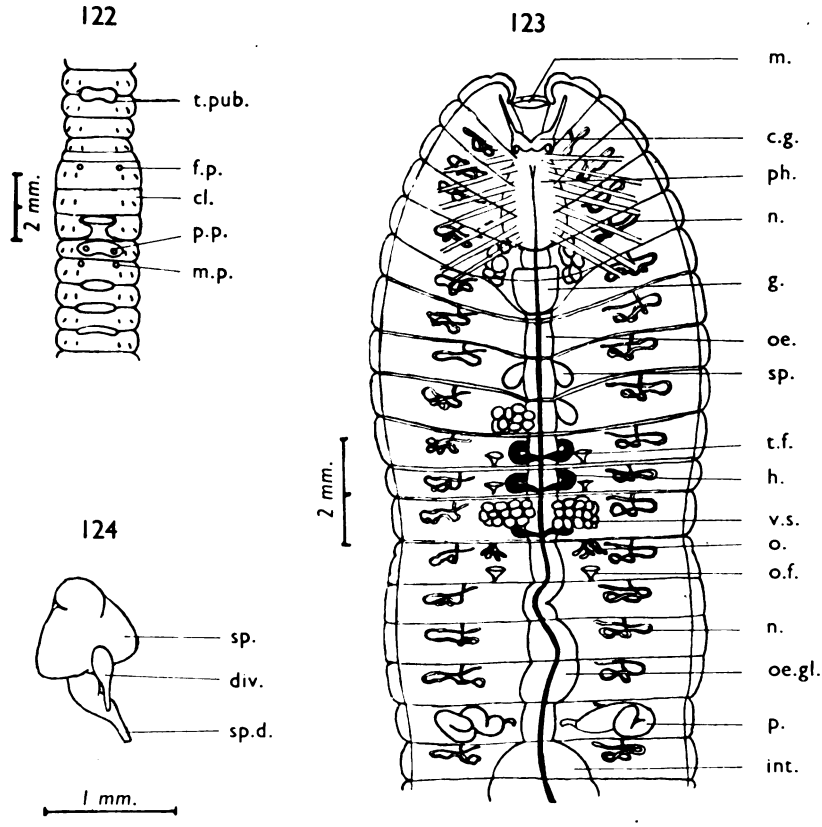

FIGS. 122–124. *Rhododrilus dobsoni* n.sp.
122. Ventral aspect, segments x–xxi
123. Dissection from dorsal aspect, segments i–xviii
124. Left anterior spermatheca, medial aspect

Septa vii/viii to xii/xiii slightly thickened.

Pharynx in i–iv, covered with salivary gland tissue which extends from the posterior portion of the pharynx into v. Proventriculus in anterior portion of v, short, narrow, thin walled. Gizzard in remainder of v, short, narrow, thick walled. Oesophagus slightly dilated in xv and xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testicular funnels in x, xi; testes not visible. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xvii, small, slender, tubular, convoluted. Penial chaetae absent. Spermathecae in viii, ix; small, conical sac with long, narrow, curved duct; small, slender, ovoidal diverticulum opens by slender duct into medial aspect of spermathecal duct. (Fig. 124).

Nephridia without vesicles.

Type Locality: 1 mile E. of Dobson, Westland; subsoil, rough pasture; K.E.L., 7/1/52.

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Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 1 specimen.

Rhododrilus edulis Benham. Figs. 125, 126

1904 *Rhododrilus edulis* Benham, Proc. zool. Soc. Lond., 1904 (2), p. 230–5.
1905 *Rhododrilus edulis,* Benham, Trans. N.Z. Inst. 37:283.
1907 *Rhododrilus edulis,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1937 *Rhododrilus edulis,* Pickford, Monograph p. 89.
1952 *Rhododrilus edulis,* Lee, Trans. roy. Soc. N.Z. 79:539.

Length 275–285 mm. Diameter 13 mm. c.300 segments; ii–v biannulate; vi–xii quadriannulate; remainder of segments triannulate.

Colour pale greyish anteriorly, remainder of body red dorsally, pale ventrally with buff clitellum.

Clitellum xiii–xviii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: dd>aa>bc>cd; ab=cd.

Prostatic pores, male pores and penial chaetal sacs all open to the exterior at the apex of low rounded papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, in line with chaeta b; the sac and the diverticulum open separately, but close together.

Nephridiopores in line with chaeta c.

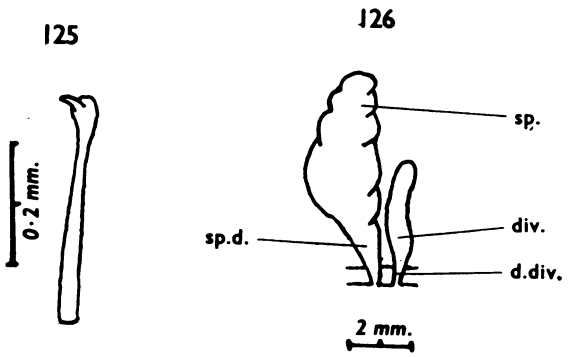
Body wall very thick and septa vii/viii to xii/xiii very thick.

Gizzard in v, large, thick walled. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxi, long, tubular, convoluted.

Penial chaetal sacs extending through xvii–xx; stout nearly straight spine, terminating in a rounded knob which carries at its end a short,



FIGS. 125, 126. *Rhododrilus edulis*
125. Tip of penial chaeta
126. Spermatheca
(Drawings after Benham, 1904b)

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stout, curved, blunt hook; about half way along the spine is a series of rather closely set, irregularly arranged, short, oblique and finely serrated ridges (Fig. 125). Copulatory muscles in xvii. Spermathecae in viii; large elongate sac, broadest in middle (about 8 mm. × 2·5 mm), without a definite duct, but narrowing as it approaches the body wall; diverticulum narrow and tubular, more than half length of sac and about one fourth of its diameter, opening independently of the sac itself into a small external groove. (Fig. 126).

Nephridia similar in form to those of *R. intermedius* and *R. macroseptus,* with long, tubular nephridial vesicles.

Type Locality: Ruatahuna, Urewera Country; W. B. Benham, 1904.

Type (?) material in Otago Museum (No. A.43.43); 2 specimens, 1 cut into small fragments, well preserved.

Localities:

North Island: Palmerston North; under oak trees in a park; R. L. Nielson, 5/51; 2 specimens. (These specimens were probably introduced into the park with plants).

Rhododrilus huttoni (Benham)

1901 *Microscolex huttoni* Benham, Trans. N.Z. Inst. 33:142–4.
1905 *Microscolex Huttoni,* Michaelsen, Dtsch. SüdpolExped. 9, Zool., 1:23.
1907 *Rhododrilus Huttoni,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1937 *Rhododrilus huttoni,* Pickford, Monograph p. 89.
1942 *Rhododrilus huttoni,* Benham, Trans. roy. Soc. N.Z. 79:537.

Length 90–125 mm. Diameter 2·5 mm. 130–136 segments.

Colour pink with light brown clitellum.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; dd>bc>aa>ab.

Prostatic pores on small rounded papillae on xvii, in line with chaeta a.

Male pores on same papillae as prostatic pores, in same line but slightly posterior to prostatic pores, not in seminal grooves.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Septa vi/vii to xii/xiii slightly thickened.

Proventriculus in v. Gizzard in vi, elongate. Oesophageal glands in xiii. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, those of xii larger than those of x, xi.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose; coelomic cavities of x, xi filled with loose sperm cells. Prostates in xvii–xxv, tubular, extending straight back to xxv, where they are slightly coiled. Penial chaetae in long sacs, in xvii–xxiii; very long spine, curving abruptly near distal end and with hook-like point. Spermathecae in viii, ix; pyriform sac with narrow duct about same length as sac; single tubular diverticulum opens into lateral aspect of

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duct near body wall, diverticulum relatively wide, slightly undulating, not distended dorsally.

Nephridia without vesicles.

Type Locality: Chatham Island; in the "bush"; W. B. Benham, 1901.

Type ? material in Otago Museum (No. A.56.30); 11 specimens, in good condition.

Previous Records:

Benham (1942) mentions two specimens collected by R. G. Turbott from South East Island, Chatham Is., from leaf mould.

Rhododrilus insularis n.sp. Figs. 127–129

Length 20 mm. Diameter 2 mm. 93 segments.

Colour deep reddish-purple with pale reddish clitellum (in alcohol).

Clitellum xiv–xvi, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd=2ab; aa=bc; dd>cd>aa>ab.

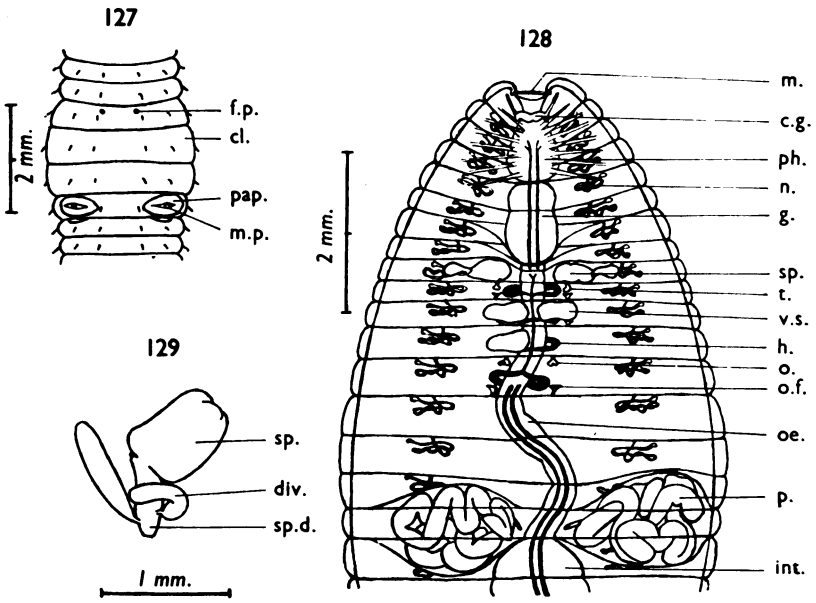
Combined male and prostatic pores on xvii in position of chaeta b, each situated in a small transverse groove on a transverse, elliptical, raised, white papilla, extending from chaeta a to about half way between the line of chaeta b and chaeta c.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Tubercula pubertatis lacking.



FIGS. 127–129. *Rhododrilus insularis* n.sp.
127. Ventral aspect, segments xii–xix
128. Dissection from dorsal aspect, segments i–xviii
129. Left spermatheca, posterior aspect

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No specially thickened septa.

Pharynx in i–iv, small. Proventriculus in v, small, thin walled. Gizzard in vi–vii, narrow, thick walled. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, tubular, coiled, convoluted, very large. Penial chaetae absent. Spermathecae in ix; large, flat sac directed medially at sharp angle to long duct; two long tubular diverticula, one lateral and one medial, open by very short narrow ducts into spermathecal duct; medial diverticulum curves around behind spermathecal duct, lateral diverticulum uncurved. (Fig. 129).

Nephridia with small vesicles.

Type Locality: South West Island, Three Kings Is.; ex leaf mould; Major M. E. Johnston, Jan. 1952.

Type specimen in Auckland Museum collection.

Localities:

Three Kings Islands: Same data as type material; 1 specimen. South West Island; ex leaf mould; T. E. Woodward, 13/1/51; 2 specimens. Tasman Stm., Great Id.; in saturated silt; J. S. Edwards, 1/1/53; 1 specimen.

Rhododrilus intermedius Lee. Figs. 130–132

1952 *Rhododrilus intermedius* Lee, Trans. roy. Soc. N.Z. 79:541–2.

Length 228 mm. Diameter 10·5 mm. 175 segments; iii–viii biannulate, ix–xiii triannulate, xiv–xviii biannulate, posterior to xviii triannulate.

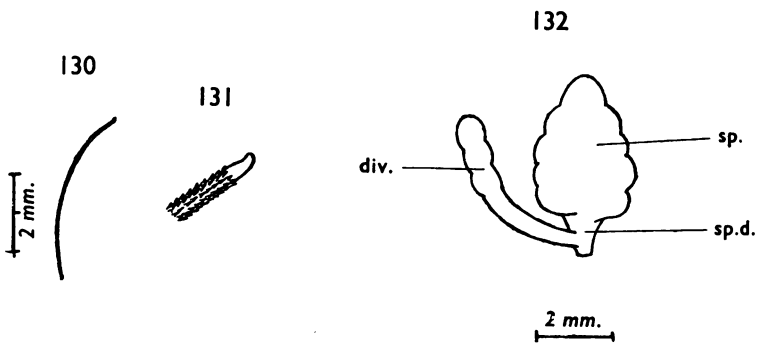
Colour brown with purplish clitellum.

Clitellum xii–xviii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: bc>aa>cd>ab; dd=2bc.

Prostatic pores and male pores combined, on very prominent conical papillae on xvii, in line with chaetal interval ab.



FIGS. 130–132. *Rhododrilus intermedius*
130. Penial chaeta
131. Tip of penial chaeta
132. Right spermatheca, anterior aspect

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Female pores on xiv, antero-lateral to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Septum vi/vii slightly thickened; septa vii/viii to xiii/xiv greatly thickened and strongly muscular; narrow longitudinal muscles join the thickened septa. The last eleven septa of the body are also much thickened and muscular.

Proventriculus in v, wide, thin walled. Gizzard in vi, wide, thick walled. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxi, tubular, convoluted. Penial chaetae in sac extending through xvii–xviii; slender, gently curved shaft with slightly recurved, blunt tip; distally, for about a third of their length, the chaetae have rows of minute spines encircling the shaft (Figs. 130, 131). Spermathecae in ix; large ovoidal sac with short duct; long tubular diverticulum, slightly irregular in outline, opens into lateral aspect of spermathecal duct. (Fig. 132).

Meganephridia commence in ii; tubules very slender, consist of three distinct parts, as follows:

Slender tubule arising from nephridial funnel and passing down lateral aspect of peritoneum.

Series of tightly wound spiral coils of tubule close to ventral nerve cord, superficially resembling a small cluster of micronephridia.

Slender tubule passing laterally across peritoneum to open to exterior through very small vesicle.

Type Locality: 10 miles S. of Ohura, beside Stratford-Ohura road; subsoil, broadleaved forest; K.E.L., 13/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 6 specimens. 5 miles S.E. of Ohura; subsoil, broadleaved forest; K.E.L., 14/5/50; 3 specimens. Mapiu, N. of Taumarunui; subsoil, podocarp-broadleaved forest; K.E.L., 16/5/50; 4 specimens.

Rhododrilus kermadecensis Benham. Figs. 133, 134

1905 *Rhododrilus kermadecensis* Benham, Trans. N.Z. Inst. 37:299–300.
1907 *Rhododrilus kermadecensis,* Michaelsen, Fauna Südwest-Aust. 1 (2): 142.
1915 *Rhododrilus kermadecensis,* Benham, Trans. N.Z. Inst. 47:147.
1937 *Rhododrilus kermadecensis,* Pickford, Monograph p. 89.
1952 *Rhododrilus kermadecensis,* Lee, Trans. roy. Soc. N.Z. 79:539.
1953 *Rhododrilus kermadecensis,* Lee, Trans. roy. Soc. N.Z. 81:49.

Length 65 mm. Diameter 1·75 mm. 108 segments.

Colour pinkish, with transparent body wall.

Clitellum xiii–xviii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd=2ab; aa=bc=cd; dd=2aa.

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Pair of rounded papillae on xvii, upon which open the male pores, the prostatic pores and the pores of the penial chaetae, in that order, anteriorly to posteriorly, slightly medial to the line of chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores in line with chaeta c.

Gizzard in v. Oesophagus dilated in xiii, xiv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii–xxii, long, tubular, almost straight. Penial chaetae in xvii–xxi; long, delicate spine, curved distally, with gently recurved spoon-shaped tip (Fig. 133). Spermathecae in vii, viii, ix; ovoidal sac with short muscular duct about half diameter of sac; long cylindrical diverticulum, curved in "S"-shape, dilated near its junction with the spermathecal duct. (Fig. 134).

Type Locality: Kermadec Islands; W. B. Benham, 1905.

The type material of this species has not been located.

Rhododrilus leptomerus Benham. Figs. 135, 136

1905 *Rhododrilus leptomerus* Benham, Trans. N.Z. Inst. 37:291.
1907 *Rhododrilus leptomerus,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1909 *Leptodrilus leptomerus,* Benham, Subant. Is. N.Z. 1:276–7.
1909 *Leptodrilus magneticus,* Benham, Subant. Is. N.Z. 1:277.
1923 *Rhododrilus leptomerus* + *Leptodrilus magneticus,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:219.
1937 *Leptodrilus leptomerus* + *Leptodrilus magneticus,* Pickford, Monograph p. 89.
1950 *Leptodrilus leptomerus,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:30.
1952 *Rhododrilus leptomerus,* Lee, Trans. roy. Soc. N.Z. 79:539.

Length 50–85 mm. Diameter 2–2·75 mm. 45–122 segments.

Colour pale yellowish-white (unpigmented) with orange brown clitellum.

Clitellum xiii–xvi, complete.

Chaetae 8/segment: aa=bc=cd>ab; dd>aa.

Prostatic and male pores combined, on papillae on xvi, in line with chaeta b.

Female pores on xiii, medial to chaeta a.

Spermathecal pores at 7/8, in line with chaeta b.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Gizzard in vi. Oesophagus dilated in xii and xiii, but no definite glands. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi.

Testes in ix, x. Ovaries in xii. Vesiculae seminales in viii, x, xi, botryoidal. Prostates extend back from xvi to xx, recurve and pass anteriorly, to terminate in xvi. Penial chaetae in xvi–xix; long, gently

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curved, sigmoid shaft without ornamentation, with spoon-shaped pointed tip (Fig. 135). Spermathecae in viii; sub-globular sac with short thick duct; large cylindrical diverticulum, bent on itself, opens into spermathecal duct. (Fig. 136).

Type Locality: Auckland Islands; on moss; W. B. Benham, 1905.

Type material in Otago Museum (No. A.54.63); 1 complete specimen and several fragments, all slightly mascerated.

Previous Records:

Subantarctic Islands: Auckland Islands (records from Benham, 1909); (a) north arm of Carnley Harbour, (b) 300 ft. above sea level, (c) Adams Island, Fairchild's garden (d) Adams Island, 2,000 ft. above sea level, (e) Enderby Island, near shore. Campbell Island (Benham, 1909). Auckland Islands (Benham, 1950); (a) Carnley Harbour, at sea level, (b) summit of Mt. Ashley; (c) summit of Flat Top Mountain.

Campbell Island, Camp Cove (Benham, 1950).

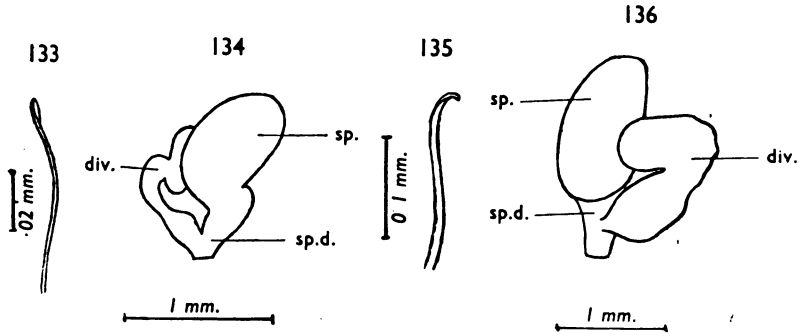
When he first described the species, Benham (1905) included it in *Rhododrilus,* but in 1909 he established the genus *Leptodrilus* for this and another species, which resembled *Rhododrilus* in all respects, except that the combined prostatic and male pores are on xvi instead of xvii, and the other genital organs are similarly one segment anterior to the positions normally found in *Rhododrilus. Rhododrilus leptomerus* was transferred to *Leptodrilus* and became the type species of the genus. The second species, *L. magneticus,* was described at the same time (1909). The description reads as follows:

"A solitary individual was collected, with several other species, at the magnetic station no. 1, at Camp Cove. It differs from the preceding [*L. leptomerus*] in the following points:

"The dimensions are greater, the length being 130 mm. by 2 mm., with 130 segments.

"Chaetal formula: bc=2ab<aa; bc slightly greater than cd.

"The clitellum occupies segments xiii to ½xvi.



FIGS. 133, 134. *Rhododrilus kermadecensis*
133. Tip of penial chaeta
134. Spermatheca
(Drawings after Benham, 1905b)
FIGS. 135, 136. *Rhododrilus leptomerus*
135. Tip of penial chaeta
136. Spermatheca
(Drawings after Benham 1905c)

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"Small paired tubercula pubertatis on the thirteenth and fourteenth segments, post chaetal in position; and a median one on the nineteenth.

"There is but one pair of spermathecae, in the eighth segment.

"The penial chaetae are more strongly bent than in the preceding, and resemble those of *R. cockayni.*"

The differences are insufficient to justify separation of this species from Benham's *"L. leptomerus"*, for the following reasons:

The dimensions and number of segments are not significantly different.

The chaetal formula is not significantly different.

The clitellum covers only half a segment less.

Tubercula pubertatis are frequently variable, both in number and position, and are not reliable taxonomic characters.

There is only one pair of spermathecae in *"L. leptomerus"*, also in viii. There is a difference in the form of the spermatheca, but it is slight.

Bending of the penial chaetae is of little taxonomic importance.

"L. magneticus" is therefore combined with *"L. leptomerus."*

Rhododrilus macroseptus Lee. Figs. 137, 138

1952 *Rhododrilus macroseptus* Lee, Trans. roy. Soc. N.Z. 79:547–8.

Length 386 mm. Diameter 11 mm. 236 segments, all with secondary annulations, varying in number from two to seven on each segment.

Colour pale pink when alive, colourless in alcohol.

Clitellum ½xiii–½xviii, complete.

Prostomium prolobous.

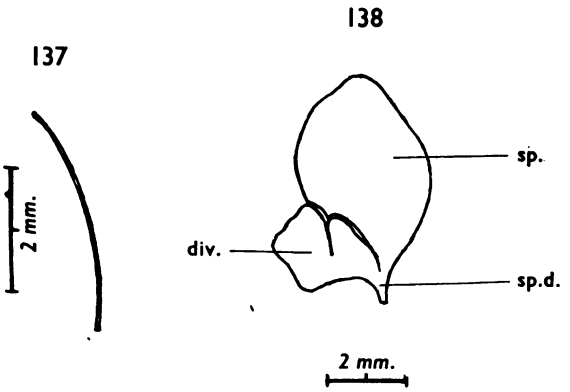
Chaetae 8/segment: cd>ab; dd>bc>aa>cd.

Combined prostatic and male pores on prominent conical papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, antero-lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.



FIGS. 137, 138. *Rhododrilus macroseptus*
137. Penial chaeta
138. Right posterior spermatheca, anterior aspect

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Septa vi/vii to xi/xii very greatly thickened and strongly muscular, xii/xiii to xiv/xv slightly thickened.

Gizzard in v–vi, slender, thick walled. Oesophageal glands in xiv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xx, tubular, convoluted. Penial chaetae in xvii; long, gently curved shaft with rounded tip; there appear to be very small spines on the shaft, but they are so small that it is difficult to distinguish them (Fig. 137). Spermathecae in viii, ix; flattened oval sac pressed against ventro-lateral aspect of body wall; small diverticulum of irregular shape lies against lateral aspect of sac and opens by short narrow duct into spermathecal duct. (Fig. 138).

Nephridia of form similar to *R. intermedius,* with small vesicles.

Type Locality: Hakarimata Range, W. Waikato; subsoil, broadleaved forest; K.E.L., 19/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Ngaruawahia; subsoil, broadleaved forest; K.E.L., 20/5/50; 1 specimen. Raglan, subsoil, broadleaved forest; K.E.L., 21/5/50; 1 specimen. Te Rau-a-Moa; subsoil, broadleaved forest, K.E.L., 21/5/50; 1 specimen. Whatawhata, W. Waikato; subsoil, broadleaved forest; K.E.L., 24/5/50; 1 specimen.

Rhododrilus microgaster n.sp. Figs. 139–142

Length 112 mm. Diameter 8 mm. 107 segments.

Colour very dark green (almost black) when alive; the colour fades very quickly to sienna brown in alcohol.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd≫aa.

Combined prostatic and male pores on low, rounded papillae on xvii, in position of chaeta a.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, medial to line of chaeta a.

Nephridiopores in line with chaeta c.

Single, median, oval tuberculum pubertatis on ventral surface of xviii, extending from chaeta a on one side, to chaeta a on the other side.

Septa viii/ix to xiv/xv muscular and thickened.

Pharynx in i–iv, covered by thick mass of salivary glands.

Gizzard in v, small and slender. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, botryoidal. Prostates in xvii–xviii; the glandular portion of each prostate is in xviii, with the duct passing through xvii/xviii into xvii; the glandular portion appears superficially to be divided into lobes, but

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there is only one axial canal discharging into the duct. Penial chaetae in xvii; long slender shaft, sharply bent about half way along its length, the whole shaft spirally twisted, terminating in a recurved, blunt point (Fig. 141). Spermathecae in viii, ix; small, elongate, cylindrical sac opening by long, narrow, muscular duct; small globular diverticulum opening by short narrow duct into medial aspect of spermathecal duct. (Fig. 142).

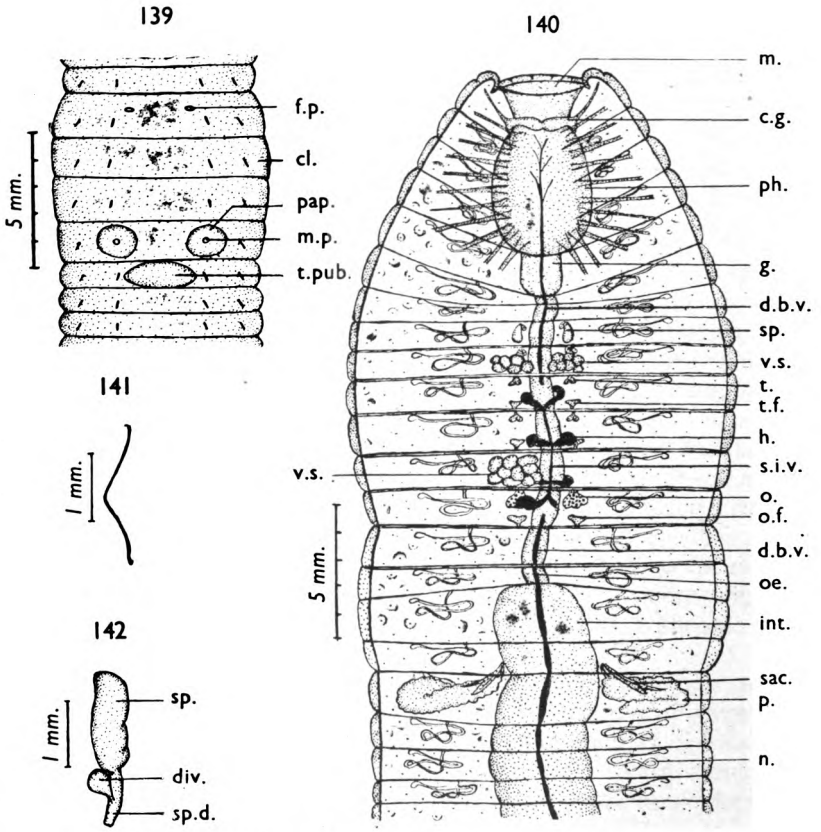
Nephridia with small vesicles.

Type Locality: 10 miles S. of Te Araroa, near East Cape; subsoil, forest; K.E.L., 11/1/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen.



FIGS. 139–142. *Rhododrilus microgaster* n.sp.
139. Ventral aspect, segments xiii–xx
140. Dissection from dorsal aspect, segments i–xx
141. Penial chaeta
142. Left posterior spermatheca, medial aspect

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Rhododrilus minimus Lee. Figs. 143, 144

1952 *Rhododrilus minimus* Lee, Trans. roy. Soc. N.Z. 79:550–2.

Length 54 mm. Diameter 2 mm. 118 segments.

Colour unpigmented, pale greyish-white in alcohol.

Clitellum not distinguishable.

Prostomium tanylobous.

Chaetae 8/segment: cd>ab; bc=cd; dd>aa>bc.

Prostatic pores on small rounded papillae on xvii, in line with chaetal interval ab.

Male pores on small pale area on anterior margin of xviii, in line with prostatic pores.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, ventro-lateral.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Proventriculus in v, short, wide, thin walled. Gizzard in vi, long, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxii, tubular, convoluted. Penial chaetae in xvii; slender curved shaft, sharply curved distally and terminating in a straight, pointed portion (Fig. 143). Spermathecae in vi, vii, viii, ix; antero-posteriorly flattened irregular sac, opening by narrow duct to the exterior; small cylindrical diverticulum lateral to sac, but at right angles about half way along its length and opening by very short narrow duct into spermathecal duct. (Fig. 144).

Nephridial vesicles present.

Type Locality: Grey's Bush, near Gisborne; topsoil, podocarp forest; K.E.L., 22/11/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 16 specimens. 20 miles N. of Wairoa; topsoil, broadleaved forest; K.E.L., 25/11/49; 6 specimens. Wairenga-o-Kuri; topsoil, broadleaved forest; K.E.L., 25/11/49; 5 specimens. Waihirere Reserve, Gisborne; topsoil, manuka scrub; K.E.L., 22/11/49; 5 specimens. 5 miles S. of Tolaga Bay; topsoil pasture; K.E.L., 23/11/49; 1 specimen. 10 miles S. of Te Araroa; topsoil, forest; K.E.L., 11/1/51; 5 specimens. 10 miles S. of Te Araroa; topsoil, pasture; K.E.L., 11/1/51; 2 specimens. Te Araroa; topsoil, broadleaved forest; K.E.L., 11/1/51; 2 specimens. Potaka, near Hicks Bay; topsoil, broadleaved forest; K.E.L., 11/1/51; 4 specimens. Cape Runaway; topsoil, broadleaved forest; K.E.L., 11/1/51; 4 specimens. Omaio, near Te Kaha; topsoil, broadleaved forest; K.E.L., 12/1/51; 1 specimen. Beside Motu R., near Opotiki; topsoil, manuka scrub; K.E.L., 12/1/51; 1 specimen. Torere, near Opotiki; topsoil, manuka scrub; K.E.L., 12/1/51; 1 specimen.

Rhododrilus minutus Beddard

1889 *Rhododrilus minutus* Beddard, Proc. zool. Soc. Lond., 1889, p. 381.
1890 *Rhododrilus minutus,* Benham, Quart. J. micr. Sci. 31:245.
1891 *Rhododrilus minutus,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Rhododrilus minutus,* Beddard, Ann. Mag. nat. Hist., ser. 6, 9:130.
1893 *Microscolex minutus,* Beddard, Proc. R. phys. Soc. Edinb. 12:36.

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1895 *Microscolex minutus,* Beddard, Monograph p. 463.
1900 *Rhododrilus minutus,* Michaelsen, Tierreich 10:143.
1901 *Microscolex minutus,* Benham, Trans. N.Z. Inst. 33:142.
1905 *Microscolex minutus,* Michaelsen, Dtsch. SüdpolExped. 9, Zool., 1:23.
1905 *Microscolex minutus,* Ude, Z. wiss. Zool. 83:419.
1907 *Rhododrilus minutus,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1910 *Rhododrilus minutus,* Michaelsen, Mitt. zool. Mus. Hamb. 27:63.
1937 *Rhododrilus minutus,* Pickford, Monograph pp. 89, 593.

Length 65 mm. Diameter 1·5–2 mm. 100 segments.

Colourless with brownish clitellum.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd>aa.

Prostatic pores and male pores very close together (or coincident?) on round, low papillae on xvii, in line with chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, ventro-lateral.

Nephridiopores in line with chaeta b.

Septa vi/vii to xi/xii thickened.

Gizzard in v. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxiv, tubular, running straight back beside ventral nerve cord. Penial chaetae in xvii–xxiv; very long, slender shaft, distally curved in sigmoid shape, flattened and bifid, with transverse rows of fine teeth. Spermathecae in vi, vii, viii, ix; pyriform sac with short, narrow duct; narrow, tubular diverticulum about twice length of sac opens into spermathecal duct close to body wall.

Nephridia without vesicles.

Type Locality: Unknown.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration no. 1904. 10.

Localities:

South Island: Ashley Downs, N. Canterbury; topsoil, pasture; A. C. S. Wright, 16/8/51; 2 specimens. Glenroy, N. Canterbury; topsoil, pasture; A. C. S. Wright, 18/8/51; 2 specimens.

Previous Records:

South Island: Port Hills, Lyttelton; H. Ude, 1905.

Rhododrilus papaensis Lee. Figs. 145, 146

1952 *Rhododrilus papaensis* Lee, Trans. roy. Soc. N.Z. 79:546–7.

Length 126 mm. Diameter 4 mm. 194 segments.

Colour pale yellowish brown with sienna brown clitellum.

Clitellum xiii–xvii, complete except for area between prostatic papillae on xvii.

Prostomium proepilobous.

Chaetae 8/segment: cd=2ab; aa=bc>cd; dd=2aa.

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Prostatic pores on small, rounded papillae on xvii, in line with chaetal interval ab.

Seminal grooves pass back from prostatic pores to anterior margin of xviii.

Male pores at anterior margin of xviii, at ends of seminal grooves.

Female pores on xiv, antero-medial to chaeta a.

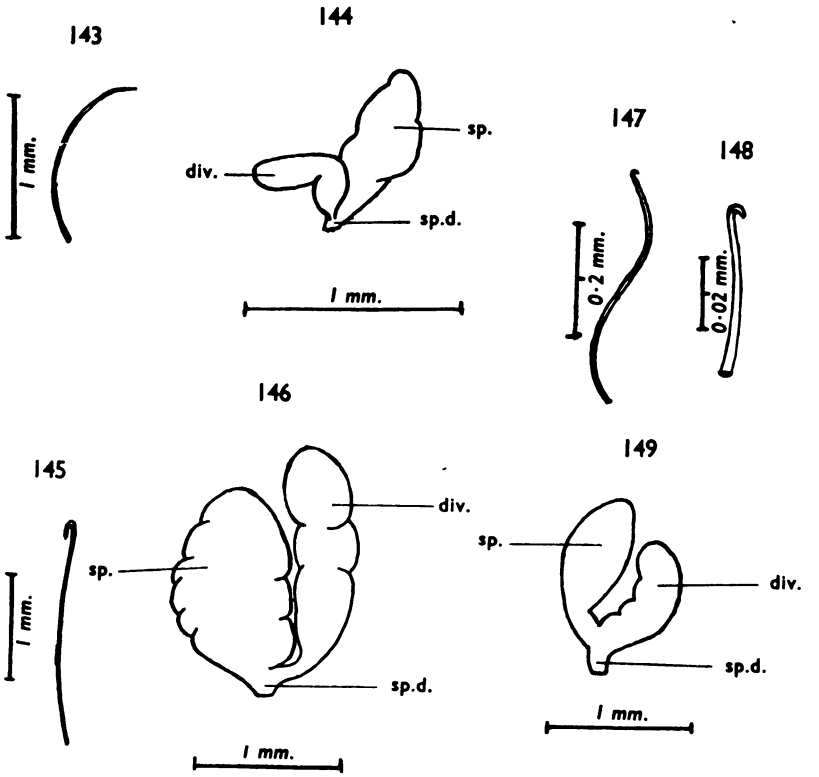
Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores in line with chaeta c.

Septa vi/vii to xii/xiii thickened.

Proventriculus in v, short, wide, thin walled. Gizzard in vi, large, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.



FIGS. 143, 144. *Rhododrilus minimus*
143. Penial chaeta
144. Right posterior spermatheca, anterior aspect
FIGS. 145, 146. *Rhododrilus papaensis*
145. Penial chaeta
146. Left posterior spermatheca, medial aspect
FIGS. 147–149. *Rhododrilus parvus*
147. Penial chaeta
148. Tip of penial chaeta
149. Spermatheca
(Drawings after Benham, 1906a)

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Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxi, tubular, extending straight back to xxi, where they are slightly coiled. Penial chaetae in xvii; elongate slightly curved shaft sharply recurved distally in a pointed hook (Fig. 145). Spermathecae in viii, ix; large ovoidal sac with very short narrow duct; long cylindrical diverticulum, longer than sac, opens by narrow duct into anterior aspect of spermathecal duct. (Fig. 146).

Nephridia with small vesicles.

Type Locality: Wairenga-o-Kuri, S. of Gisborne; topsoil, broadleaved forest; K.E.L., 25/11/49. Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Waioeka Gorge, 27 miles S. of Opotiki; topsoil, broadleaved forest; 4 specimens. Waioeka Gorge, 35 miles S. of Opotiki; topsoil, podocarp-broadleaved forest; K.E.L., 13/1/51; 2 specimens.

Rhododrilus parvus Benham. Figs. 147–149.

1906 *Rhododrilus parvus* Benham, Trans. N.Z. Inst. 38:250–1.
1907 *Rhododrilus parvus,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1937 *Rhododrilus parvus,* Pickford, Monograph p. 89.
1952 *Rhododrilus parvus,* Lee, Trans. roy. Soc. N.Z. 79:539.

The following description is taken from Benham (1906), with some additional information derived from a re-examination of type and named specimens in Benham's collection. The specimens are in rather poor condition and it has not been possible to compile a full description of the species.

Length 55–65 mm. Diameter 2–3 mm. c.120 segments.

Colourless.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium not described by Benham; the specimens are not in good enough condition for the type of prostomium to be identified, since the anterior segments are longitudinally furrowed.

Chaetae 8/segment: ab=cd; aa=bc>ab; dd>aa.

Combined prostatic and male pores on small papillae on xvii, in line with chaeta b.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 8/9, in line with chaeta b.

No specially thickened septa.

Gizzard large and strong. Oesophageal glands in viii, ix. Intestine commences in xvi.

Dorsal blood vessel unpaired.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xxiii, tubular. Penial chaetae in sacs extending from xvii to xxiv; slender sigmoid spine with tip recurved in hook and pointed (Figs. 147, 148). Spermathecae in ix; ovoidal sac with fairly long duct; large tubular diverticulum, almost as long as sac, opens directly into spermathecal duct about halfway along its length, without any distinct diverticular duct. (Fig. 149).

Nephridial vesicles lacking.

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Type Locality: Little Barrier Island; in banks of stream in dense forest; W. B. Benham, 1906.

Type (?) material in Otago Museum (No. A.43.39); 2 specimens, in poor condition.

Localities: None.

Collections have been made from Little Barrier Island in the present investigation, but this species has not been re-collected.

Rhododrilus ravus n.sp. Figs. 150–152

Length 32·5 mm. Diameter 3·25 mm. 96 segments.

Colour bluish grey with pale brown clitellum.

Clitellum xiv–⅓xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd>aa.

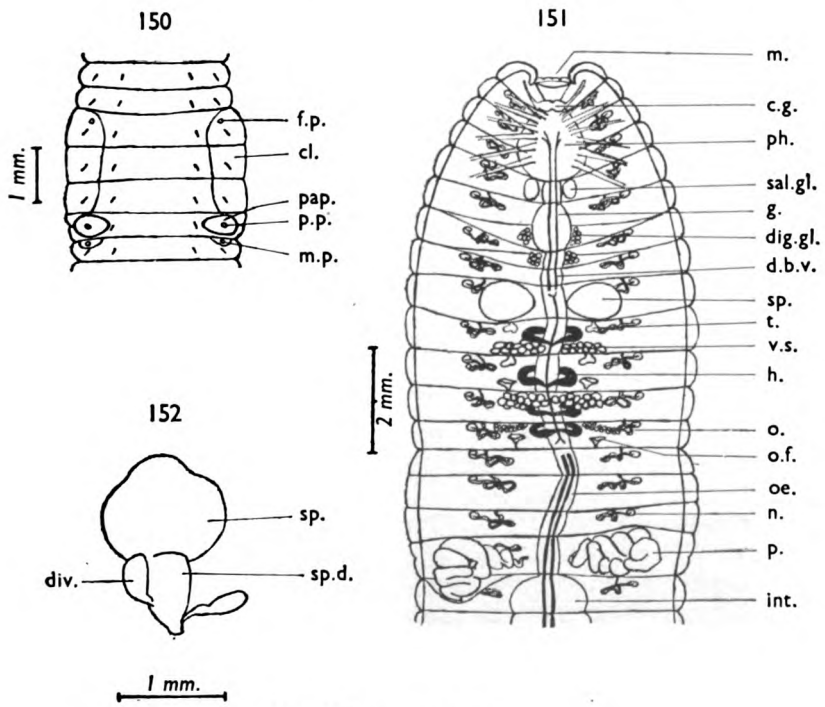
Prostatic pores on broad flat papillae on xvii, in position of chaeta b.

Male pores at extreme anterior margin of xviii, in line with prostatic pores.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.



FIGS. 150–152. *Rhododrilus ravus* n.sp.
150. Ventral aspect, segments xii–xviii
151. Dissection from dorsal aspect, segments i–xviii
152. Left spermatheca, posterior aspect

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No tubercula pubertatis.

No specially thickened septa.

Pharynx in i–iv. Proventriculus in v, slender, thin walled. Gizzard in vi, small, round, thick walled. Oesophageal glands absent. Intestine commences in xviii. A pair of salivary glands lie in v and open by ducts into the pharynx in iv. Small botryoidal digestive glands lie on either side of the alimentary canal in vi and vii and open by slender ducts into the gizzard.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xii, botryoidal. Prostates in xvii, very long, tubular, tightly coiled. Penial chaetae absent. Spermathecae in ix; large spheroidal sac with long, wide, muscular duct; two small diverticula, one long, narrow, cylindrical (medial) and one short, thick, pyriform (lateral) open by short slender ducts into the spermathecal duct. (Fig. 152).

"J"-shaped nephridial vesicles (*"Acanthodrilus"* type) present.

Type Locality: Crater Head, Great Island, Three Kings Is.; in forest leaf mould on rock outcrop; J. S. Edwards, 5/1/53.

Type specimen in Auckland Museum collection.

Localities:

Three Kings Islands: Same data as type material; 1 specimen. Tasman Stm, Great Id.; among pebbles in streamside silt; J. S. Edwards, 30/12/52; 1 specimen. Eastern Arm, Great Id., ex dry surface litter in forest; J. S. Edwards, 1/1/53; 5 specimens. Eastern Arm, Great Id.; ex humus, scrub; J. S. Edwards, 2/1/53; 4 specimens. Eastern Arm, Great Id.; ex humus under moss; J. S. Edwards, 1/1/53; 1 specimen. Near summit of Great Id.; ex humus under scrub; J. S. Edwards, 4/1/53; 7 specimens. Tasman Valley, Great Id.; ex humus under *Cordyline*; J. S. Edwards, 5/1/53; 1 specimen. Tasman Valley, Great Id.; ex humus under scrub; J. S. Edwards, 5/1/53; 5 specimens. Tasman Valley, Great Id.; ex leaf mould under *Colensoa*; J. S. Edwards, 5/1/53; 1 specimen. Eastern Peak, Great Id.; Auckland Museum, Dec. 1945; 2 specimens. (All specimens from Auckland Museum collection).

Rhododrilus robustus Lee. Fig. 153

1952 *Rhododrilus robustus* Lee, Trans. roy. Soc. N.Z. 79:553–4.

Length 55 mm. Diameter 3·5 mm. 105 segments.

Colour pale pink with buff clitellum.

Clitellum xiii–xvii, complete.

Prostomium tanylobous.

Chaetae 8/segment: cd>ab; aa=bc>cd; dd≫aa.

Prostatic pores on xvii, in position of chaeta a; not on papillae, pores not visible externally.

Male pores on extreme anterior margin of xviii, in line with chaeta a.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 4/5, 5/6, 6/7, 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores in line with chaeta c.

No specially thickened septa.

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Proventriculus in v, short, wide, thin walled. Gizzard in vi, long, wide, thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii, racemose. Prostates in xvii–xxiii, tubular, slightly convoluted. Penial chaetae in xvii. Spermathecae in v, vi, vii, viii, ix, each consisting of two slender ovoidal lobes; lateral lobe thick walled, opening to exterior through thick-walled muscular atrium; medial lobe thin walled, opening through very slender duct into lowest point of medial aspect of muscular atrium of lateral lobe. (Fig. 153).

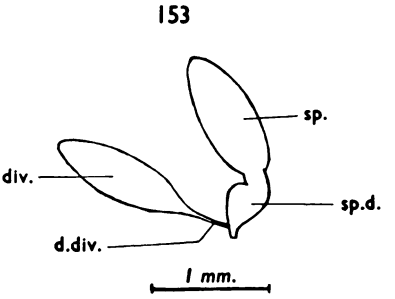

FIG. 153. *Rhododrilus robustus.* Left spermatheca of vii, anterior aspect

Nephridial vesicles small.

Type Locality: Ball's Clearing Forest Reserve, Puketitiri, W. Hawke's Bay; topsoil, beech forest; K.E.L., 5/7/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 7 specimens. Same data; K.E.L., 29/11/49; 1 specimen. Ball's Clearing; topsoil, scrub and tussock; K.E.L., 5/7/49; 6 specimens. Same data; K.E.L., 29/11/49; 1 specimen. Patoka, Hawke's Bay; topsoil, pasture; K.E.L., 5/7/49; 2 specimens. Same data; K.E.L., 1/12/49; 1 specimen. Raukawa Valley, Hawke's Bay; topsoil, broadleaved forest; K.E.L., 6/7/49; 1 specimen. Same data; K.E.L., 1/12/49; 2 specimens. The Bluff, Te Aute; topsoil, broadleaved forest; K.E.L., 7/7/49; 17 specimens. Same data; K.E.L., 28/11/49; 5 specimens. Blowhard Ra., W. Hawke's Bay; topsoil, bracken, scrub and grasses; K.E.L., 12/10/50; 2 specimens. Blowhard Ra., W. Hawke's Bay; topsoil, broadleaved forest; K.E.L., 12/10/50; 10 specimens. Tarua Rau Hill, Napier-Taihape Road; topsoil, tussock; K.E.L., 12/10/50; 2 specimens. National Park; topsoil, tussock; K.E.L., 12/5/50; 7 specimens. Waiouru; topsoil, *Libocedrus* forest; A. C. S. Wright, 25/9/50; 13 specimens. Waiouru; topsoil, *Danthonia-Festuca* tussock; A. C. S. Wright, 25/9/50, 4 specimens. Waiouru Military Camp; topsoil, *Danthonia-Festuca* tussock; K.E.L., 10/3/53; 27 specimens. Same data; R. H. Thornton, 25/9/53; 7 specimens. Waiouru Military Camp; topsoil, podocarp forest; K.E.L., 11/3/53; 6 specimens.

Rhododrilus rosae n.sp. Figs. 154–156

Length 89 mm. Diameter 4 mm. 131 segments.

Colour purplish red with chaetae on small, raised, white spots; clitellum buff.

Clitellum xiv–xvi, complete.

Prostomium tanylobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd>aa.

Prostatic pores on xvii, each in a transverse groove on a prominent papilla, in position of chaeta b. Seminal groove runs from each of the grooves containing a prostatic pore back to 17/18.

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Male pores at 17/18, at posterior ends of seminal grooves.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

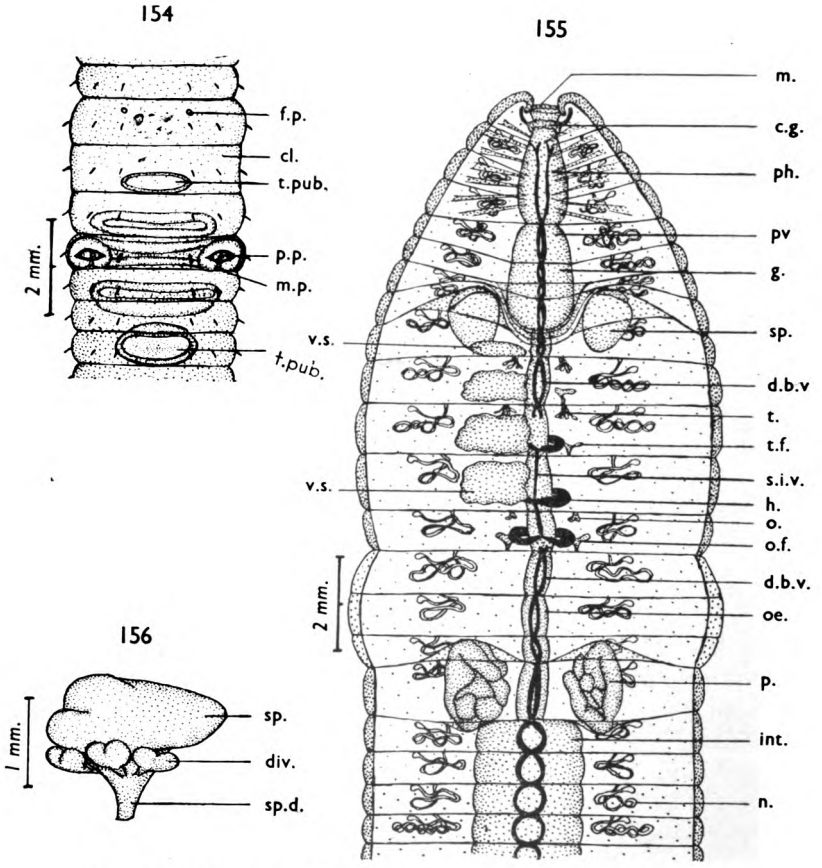
Nephridiopores in line with chaeta c.

Tubercula pubertatis are prominent, white, transversely disposed, oval, glandular pads, on the ventral surfaces of xv, xvi, xvii, xviii and xx; those of xviii and xx overlap onto xix.

No specially thickened septa.

Pharynx in i–iv, slender and with few extrinsic muscles. Proventriculus in v, short, wide, thin walled. Gizzard in vi, short, wide, thick walled. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel paired but the two vessels fuse at each septum from iv/v back. Unpaired supra-intestinal vessel commences in xi. Hearts from supra-intestinal vessel in xi, xii, xiii.



FIGS. 154–156. *Rhododrilus rosae* n.sp.
154. Ventral aspect, segments xiii–xx
155. Dissection from dorsal aspect, segments i–xxi
156. Left spermatheca, lateral aspect

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Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose; those of ix smaller than those of x, xi, xii. Prostates in xvii, wide tubular organs, tightly convoluted and coiled. Penial chaetae absent. Spermathecae in ix; large, dorso-ventrally flattened, disc-like sac, with wide duct; five small reniform diverticula encircle duct just below sac and open by short slender ducts into spermathecal duct. (Fig. 156).

Nephridial vesicles small.

Type Locality: Motuhora, Urewera Country; in leaf mould and surface soil; K.E.L., 13/1/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 3 specimens. Riverhead, Northland; under pine log in plantation; J. S. Edwards, 3/54; 1 specimen (apparently introduced).

Rhododrilus similis Benham. Figs. 157, 158

1906 *Rhododrilus similis* Benham, Trans. N.Z. Inst. 38:242–3.
1907 *Rhododrilus similis,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1937 *Rhododrilus similis,* Pickford, Monograph p. 89.
1949 *Rhododrilus similis,* Benham, Proc. zool. Soc. Lond. 119:913.
1952 *Rhododrilus similis,* Lee, Trans. roy. Soc. N.Z. 79:539.

Length 75–165 mm. Diameter 3–5 mm. 150–200 segments.

Colour white with pale yellowish white clitellum.

Clitellum ½xiii–xvii, dorsal and lateral.

Prostomium epilobous.

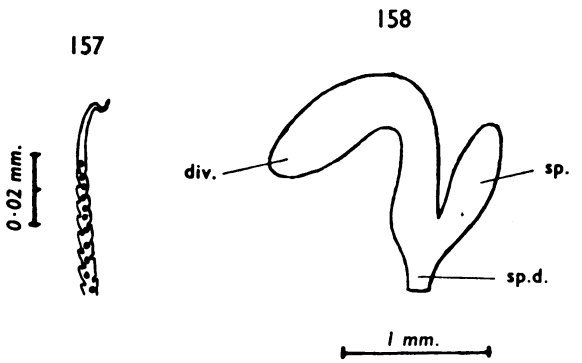
Chaetae 8/segment: ab=bc=cd; aa>ab; dd≫aa.

Combined prostatic and male pores on small rounded papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, slightly medial to line of chaeta b.

Nephridiopores in line with chaeta c.



FIGS. 157, 158. *Rhododrilus similis*
157. Tip of penial chaeta
158. Spermatheca
(Drawings after Benham, 1906b)

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No specially thickened septa.

Gizzard in v. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xxi or xxii, tubular, convoluted in last two segments. Penial chaetae in xvii; gently curved elongate shaft, with sharply recurved, pointed tip; for a short distance close to the tip, shaft ornamented with oblique pits with distally directed proximal edges. (Fig. 157).

Nephridia with small vesicles.

Type Locality: Ruatoki, Urewera Country; W. B. Benham, 1906.

Type specimen in Otago Museum (No. A.43.42); 16 specimens, preservation fair.

Localities:

North Island: Foxton; topsoil, broadleaved forest; K.E.L., 15/5/50; 2 specimens. Kotukotu Stm., W. Taupo; topsoil, scrub; A. C. S. Wright, 2/1/50; 18 specimens. Whanganui River, W. Taupo; topsoil, scrub; A. C. S. Wright, 4/1/50; 15 specimens. Waitaia Stm., W. Taupo; topsoil, scrub; A. C. S. Wright, 6/1/50; 9 specimens. Waitaia Stm; topsoil, broadleaved forest; A. C. S. Wright, 8/1/50; 6 specimens. Waihaha Ford, W. Taupo; topsoil, scrub; A. C. S. Wright, 1/51; 2 specimens. Waituhi Trig, near Taumarunui-Tokaanu road, 3,075 ft.; topsoil, moss and grass; K.E.L., 14/5/50; 9 specimens. National Park; topsoil, scrub and rushes; K.E.L., 15/5/50; 6 specimens. Chateau Tongariro; topsoil, beech forest; K.E.L., 15/5/50; 3 specimens. Okahukura, near Taumarunui; topsoil, bracken and manuka scrub; K.E.L., 16/5/50; 3 specimens. Mapiu, N. of Taumarunui; tospoil, podocarp-broadleaved forest; K.E.L., 16/5/50; 1 specimen. Whaka Forest, Rotorua; under logs and in topsoil, larch forest; K.E.L., 6/10/49; 6 specimens. Broadlands, near Rotorua; topsoil, pasture; K.E.L., 7/10/49; 10 specimens. Reporoa; topsoil, pasture; K.E.L., 7/10/49; 1 specimen. Waioeka Gorge, 10 miles S. of Opotiki; topsoil, broadleaved forest; K.E.L., 12/1/51; 5 specimens. Waioeka Gorge, 18 miles S. of Opotiki; topsoil, podocarp-broadleaved forest; K.E.L., 13/1/51; 8 specimens. Waioeka Gorge, 27 miles S. of Opotiki; topsoil, podocarp-broadleaved forest; K.E.L., 13/1/51; 1 specimen. Waioeka Gorge, 35 miles S. of Opotiki; topsoil, forest; K.E.L., 13/1/51; 1 specimen. Te Puia; topsoil, podocarp-broadleaved forest; K.E.L., 10/1/51; 7 specimens. Waiomuku R. bank, near Tolaga Bay; topsoil, manuka scrub; K.E.L., 23/11/49; 3 specimens. Otoko; topsoil, broadleaved forest; K.E.L., 24/11/49; 6 specimens. 10 miles E. of Otoko; topsoil, broadleaved forest; K.E.L., 24/11/49; 1 specimen. Waihirere Reserve, Gisborne; topsoil, manuka scrub; K.E.L., 22/11/49; 9 specimens. Wairenga-o-Kuri; topsoil, broadleaved forest; K.E.L., 25/11/49; 2 specimens. Tiniroto; topsoil, podocarp forest; K.E.L., 25/11/49; 1 specimen. Waihua, 14 miles S. of Wairoa; topsoil, manuka scrub; K.E.L., 25/11/49; 4 specimens. Thumb Track, Little Barrier Island; topsoil, scrub; J. S. Edwards, 24/8/52; 2 specimens. Hingaia, Little Barrier Id.; topsoil, coastal forest; J. S. Edwards, 26/8/52; 2 specimens. Te Waikohare Stm., Little Barrier Id.; topsoil, broadleaved forest; J. S. Edwards, 29/8/52; 1 specimen.

Rhododrilus subtilis n.sp. Figs. 159–162

Length 26·5 mm. Diameter 1·5 mm. 102 segments.

Colour pale pink with purplish clitellum.

Clitellum ½xiii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment; ab=cd; aa>bc>ab; dd=aa.

Combined prostatic and male pores on small conical papillae on xvii, in line with chaetal interval ab.

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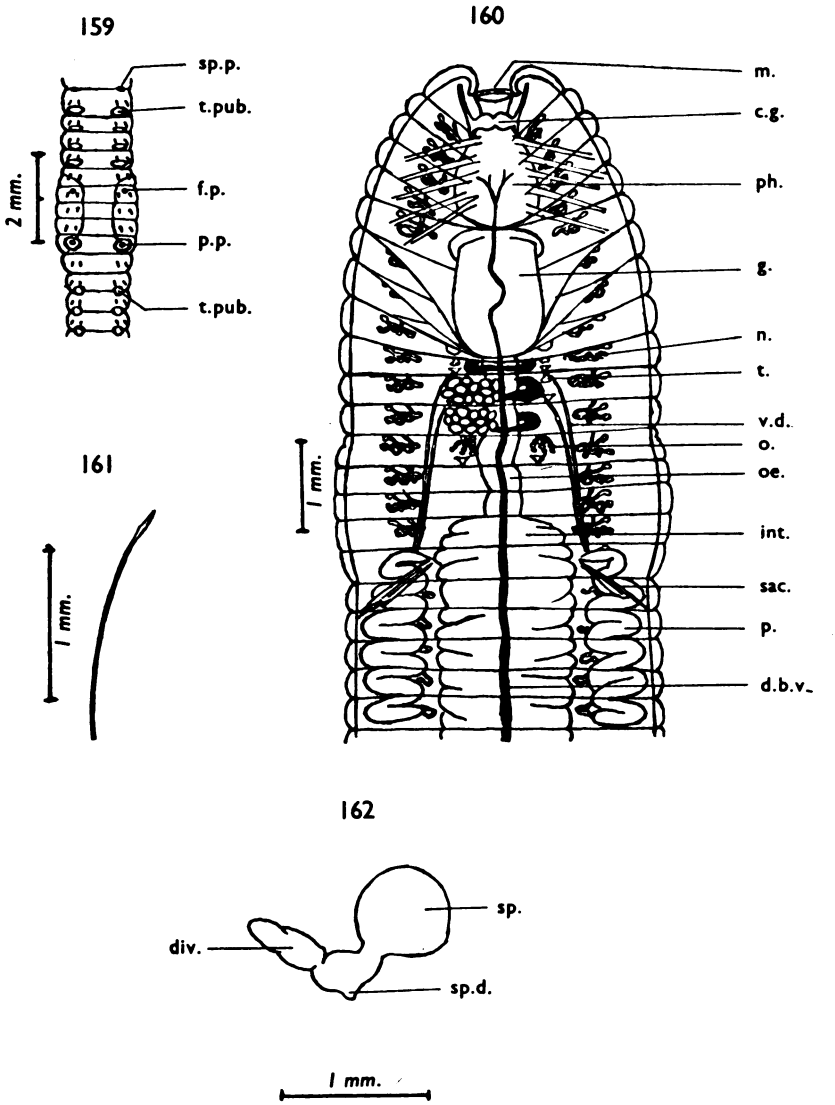
Female pores on xiv, anterior and slightly medial to chaeta b.
Spermathecal pores at 6/7, 7/8, 8/9, in line with chaeta b.
Nephridiopores in line with chaeta c.
Pairs of small oval tubercula pubertatis in line with chaeta ab on posterior margins of ix, x, xi, xii, and intersegmentally at 19/20, 20/21, 21/22.
No specially thickened septa.



FIGS. 159–162. *Rhododrilus subtilis* n.sp.
159. Ventral aspect, segments ix–xxi
160. Dissection from dorsal aspect, segments i–xxii
161. Penial chaeta
162. Right posterior spermatheca, anterior aspect

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Pharynx in i–iv. Proventriculus in v, short, narrow, thin walled. Gizzard in vi, long, wide, very thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xxii, tubular, convoluted. Penial chaetae in xvii–xviii; slender, gently curved, sharply pointed, without ornamentation (Fig. 161). Spermathecae in vii, viii, ix; small spheroidal sac opening by short duct into muscular atrium which opens by short duct to exterior; short tubular diverticulum, without duct, projects laterally from atrium. (Fig. 162).

Small nephridial vesicles present.

Type Locality: Mouth of Taepiro Stm., Kapiti Island; topsoil, rough grassy flat; K.E.L., 28/1/53.

Type specimen in Soil Bureau collection.

Localities:

Kapiti Island: Same data as type material; 3 specimens. East side of island, 1 mile S. of caretaker's house; leaf mould and shingle, coastal forest; K.E.L., 28/1/54; 5 specimens. 200 yd. S. of caretaker's house on Trig track; topsoil, coastal forest; K.E.L., 28/1/54; 6 specimens. ½ mile S. of caretaker's house on Trig track; topsoil, coastal forest; K.E.L., 28/1/54; 1 specimen. Steep slope on Trig track, 700 ft. above sea level; topsoil, coastal forest; K.E.L., 28/1/54; 1 specimen. Trig track, 1,400 ft. above sea level; topsoil, broadleaved forest; K.E.L., 26/1/54; 1 specimen. ½ mile S. of Kapiti Trig at head of Taepiro Valley; topsoil, coastal shrubs and grasses; K.E.L., 26/1/54; 4 specimens. East coast, ½ mile N. of caretaker's house on steep slope above cliff; topsoil, coastal scrub; K.E.L., 27/1/54; 1 specimen. Steep slope 30 ft. above sea level near N. end of island; leaf mould and shingle, coastal forest; K.E.L., 27/1/54; 5 specimens.

Rhododrilus sutherlandi Lee. Figs. 163, 164

1952 *Rhododrilus sutherlandi* Lee, Trans. roy. Soc. N.Z. 79:544–6.

Length 143 mm. Diameter 2 mm. c.150 segments.

Colourless with pale brownish clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa=bc=dd>ab.

Combined prostatic and male pores on prominent rounded papillae on xvii, in line with chaetal interval ab.

Female pores on xiv, antero-medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

No specially thickened septa.

Gizzard in v, long, thick walled. Oesophageal glands in xiii. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii–xx, tubular, slightly convoluted. Penial

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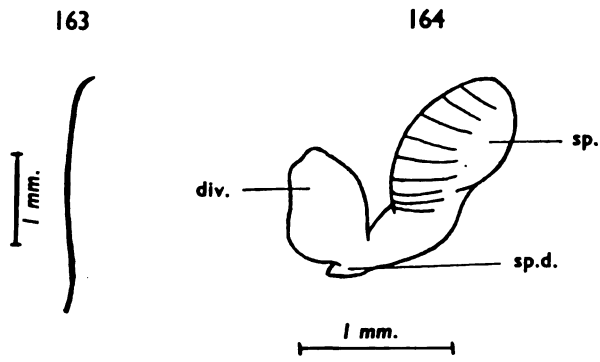

FIGS. 163, 164. *Rhododrilus sutherlandi*
163. Penial chaeta
164. Left posterior spermatheca lateral aspect

chaetae in xvii; elongate, slender, sigmoid shaft, sharply bent near tip and pointed, without ornamentation (Fig. 163). Spermathecae in viii, ix; large ovoidal sac with long wide duct; ovoidal diverticulum lies in next anterior segment and opens by short wide duct, passing through septum, into anterior aspect of spermathecal duct. (Fig. 164).

Nephridia with vesicles.

Type Locality: Tutamoe, near Whangarei; subsoil, fern and pasture grasses; K.E.L., 18/1/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 12 specimens. Tutamoe; topsoil and subsoil, broadleaved forest; K.E.L., 18/1/49; 6 specimens. Porotia, near Whangarei; subsoil, manuka scrub; K.E.L., 17/1/49; 4 specimens. Kauri, near Whangarei; leaf mould, podocarp forest; K.E.L., 26/7/51; 3 specimens. Rehia, near Dargaville; topsoil, broadleaved forest; K.E.L., 25/7/51; 2 specimens. Rehia, near Dargaville; topsoil, pasture; K.E.L., 25/7/51; 2 specimens. Matakohe, near Dargaville; subsoil, manuka scrub; K.E.L., 25/7/51; 1 specimen.

Rhododrilus tetratheca n.sp. Figs. 165–168

Length 115 mm. Diameter 4 mm. 227 segments; all those posterior to iv have secondary annulations, most being triannulate.

Colour pale brown (in alcohol).

Clitellum ½xiii–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; bc>aa>cd; dd≫aa.

Combined prostatic and male pores on small rounded papillae on xvii, in position of chaeta b.

Female pores on xiv, anterior and slightly lateral to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta c.

Small, paired, transversely elliptical, raised tubercula pubertatis at 9/10, 10/11, 19/20, 20/21, 21/22, 22/23, 23/24, in line with chaeta a.

Septa v/vi to xi/xii thickened.

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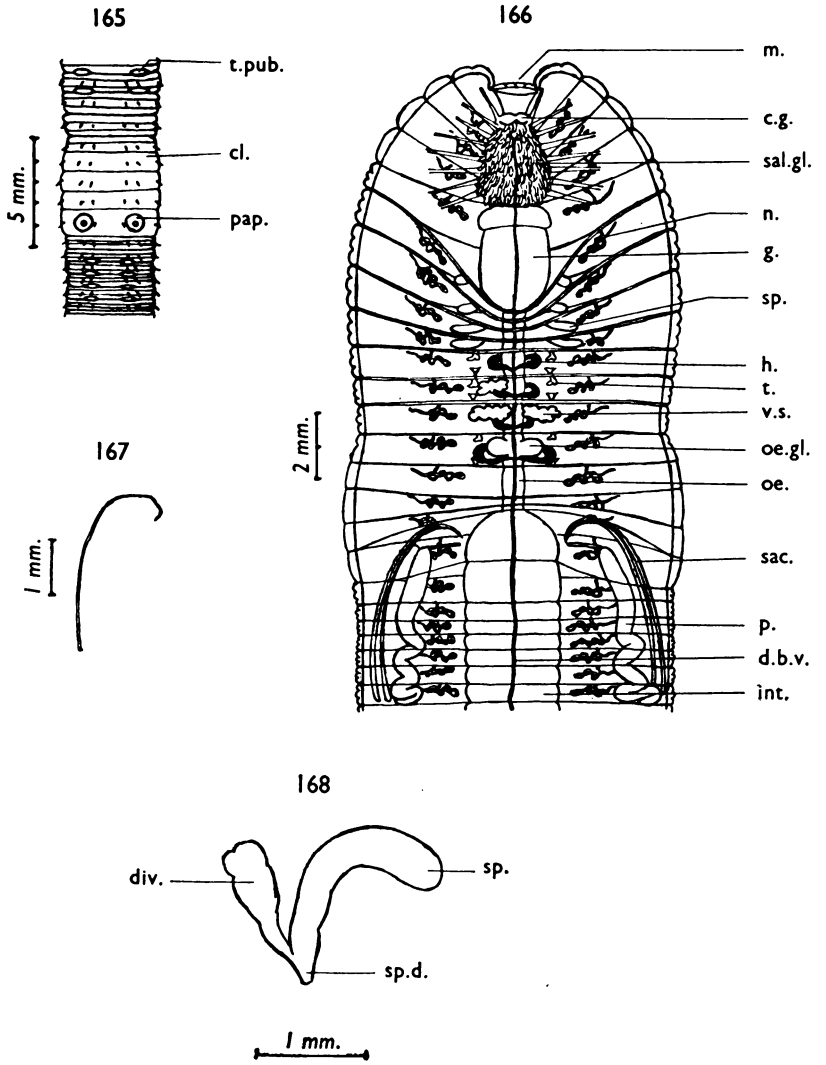
Pharynx in i–iv, covered with masses of salivary gland tissue. Gizzard in v, wide, thick walled. Oesophageal glands in xiii. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii–xxiv, tubular, convoluted in last three or four segments. Penial chaetae in long sacs in xvii–xxiv; long slender shaft without ornamentation, curved in the form of a hook, at the



FIGS. 165–168. *Rhododrilus tetratheca* n.sp.
165. Ventral aspect, segments x–xxiii
166. Dissection from dorsal aspect, segments i–xxiv
167. Penial chaeta
168. Left posterior spermatheca, anterior aspect

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tip bent at right angles to the plane of curvature and sharply pointed (Fig. 167). Spermathecae in vi, vii, viii, ix; long, curved, tubular sac, extending laterally from wide duct; shorter, uncurved, medial diverticulum opens by short duct into medial aspect of spermathecal duct. (Fig. 168).

Nephridial vesicles absent.

Type Locality: Saddle above Castaway Valley, Great Id., Three Kings Is.; subsoil; J. S. Edwards, 7/1/53.

Type specimen in Auckland Museum collection.

Localities:

Three Kings Islands: Same data as type material; 4 specimens. Castaway Valley, Great Id.; 1 ft. deep in peat; J. S. Edwards, 7/1/53; 2 specimens. Near N.W. cliffs, Great Id.; subsoil; J. S. Edwards, 3/1/53; 4 specimens. East Arm, Great Id.; under moss; J. S. Edwards, 1/1/53; 1 specimen. Near Depot, Great Id.; E. G. Turbott, 14/4/46; 1 specimen. Great Id.; E. G. Turbott, 29/4/46; 2 specimens. Great Id.; E. G. Turbott, 1/51; 2 specimens. (All specimens from Auckland Museum collection).

Genus Sylvodrilus n.g.

Chaetae eight on each segment. Prostatic pores one pair, on xix, on papillae. Seminal grooves running forward from prostatic pores onto xviii. Male pores one pair, on xviii, at anterior end of seminal grooves. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores one pair, anterior to 9/10. Nephridiopores in a single lateral series on each side of the body. Gizzard single, well developed. Dorsal blood vessel paired; four pairs of hearts, in x, xi, xii, xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates one pair, opening to the exterior in xix, tubular. Penial chaetae absent. Spermathecae anterior to x, paired, diverticula projecting through septum into next anterior segment. Meganephridial; nephridial vesicles present.

Type species: *Sylvodrilus gravus* n.sp.

Number of Species: One.

Distribution: New Zealand, confined to western districts of the South Island.

The genus is established for a single species, which resembles *Microscolex* but differs from that genus in having a well developed gizzard and in having the prostatic pores on xix, instead of on xvii or on xvii and xix.

Sylvodrilus gravus n.sp. Figs. 169–171

Length 52·5 mm. Diameter 2·5 mm. 118 segments.

Colour slate grey with greyish brown clitellum.

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment, except on last twelve segments, where there are more than eight (up to 12) on each segment: on xxiv, cd>ab; bc=cd; dd>aa>bc.

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Prostatic pores on prominent rounded papillae on xix, in line with chaeta b. Shallow seminal groove extends from prostatic pore of each side, down the anterior surface of the papilla onto xviii. Male pores at anterior ends of seminal grooves, close to posterior margin of xviii.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, in line with chaeta b.

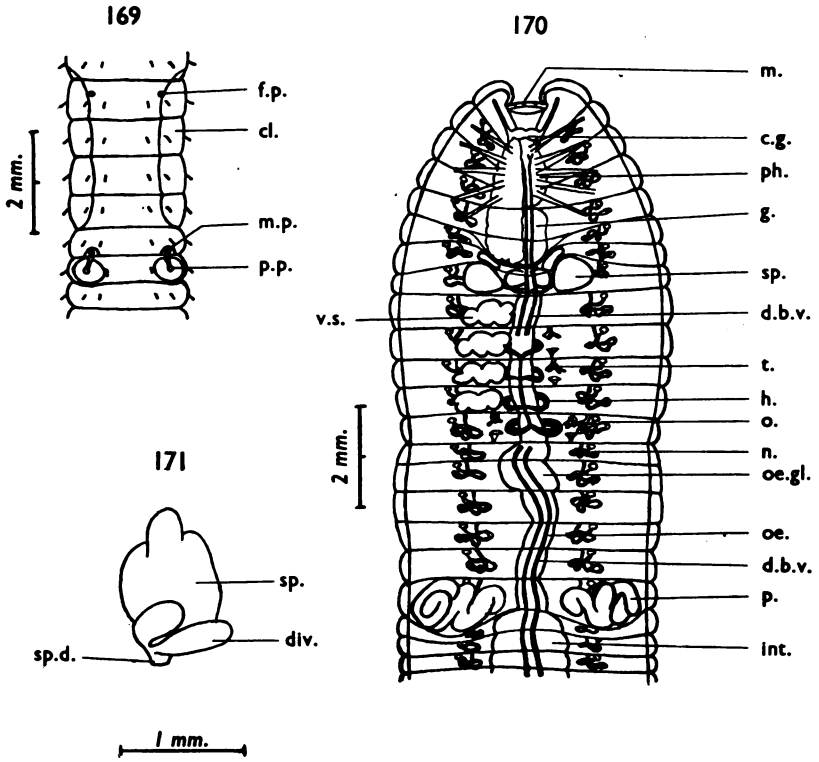
Nephridiopores in line with chaeta c.

No specially thickened septa.

Pharynx in i–iv, elongate, slender. Gizzard in v, short, wide. Masses of small salivary glands cover the dorsal and lateral aspects of the pharynx and extend back over the gizzard. Oesophagus slightly dilated in vi, more widely dilated in xiv–xv. Intestine commences in xx.

Dorsal blood vessel paired. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, sac-like. Prostates in xix, stout, tubular, convoluted, compressed. No penial chaetae nor copulatory muscles. Spermathecae in viii; large, antero-posteriorly flattened, irregular sac with short, wide duct; two



FIGS. 169–171. *Sylvodrilus gravus* n.sp.
169. Ventral aspect, segments xiv–xviii
170. Dissection from dorsal aspect, segments i–xxii
171. Right spermatheca, anterior aspect

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small tubular diverticula project side by side through vii/viii into vii and open by narrow ducts into the anterior aspect of the spermathecal duct. (Fig. 171).

Nephridial vesicles present.

Type Locality: ½ mile S. of Kaniere, Westland; topsoil, kahikitea forest; K.E.L., 16/1/53.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 5 specimens. No Name Road, near Kumara; topsoil, podocarp forest; K.E.L., 17/1/53; 2 specimens.

Tribe NEODRILACEA

Stephenson (1930), in his classification of the Acanthodrilinae, grouped three New Zealand genera, *Maoridrilus* Michaelsen, *Neodrilus* Beddard, and *Plagiochaeta* Benham, in his Sectio Neodrilacea. Michaelsen (1928) had grouped the same genera under the name "Group Maoridrilacea". These genera are distinguished from all other Acanthodrilinae by a more or less regular alternation of the nephridiopores of adjacent segments from a dorso-lateral to a ventro-lateral position. The Neodrilacea, as recognised in this work, includes the three genera of Stephenson's Sectio, together with *Neochaeta* n.g., which also has the nephridiopores alternating in position. To bring the classification into line with accepted zoological nomenclature, the term "tribe" is substituted for Stephenson's "sectio".

The four genera are endemic to New Zealand. They are closely allied to the *Eodrilus-Microscolex* group of genera and may be regarded as having evolved within the New Zealand region from a stock similar to this group. *Maoridrilus,* with 25 species, is the largest genus, and its present distribution, in the South Island and the southern portion of the North Island, covers the area of distribution of the whole tribe.

Nephridial vesicles are generally present; their form varies from a simple dilatation of the distal extremity of the nephridial duct to large vesicles of unusual form. In some species differences have been noted between the vesicles of the dorsal and ventral nephridia, but the significance of such variations has not been investigated.

Genus MAORIDRILUS Michaelsen

1899 *Maoridrilus* Michaelsen, Zool. Jahrb. Syst. 12:234.
1900 *Maoridrilus,* Michaelsen, Tierreich 10:123.
1901 *Acanthodrilus* (*Maoridrilus*), Benham, Trans. N.Z. Inst. 33:123.
1930 *Maoridrilus,* Stephenson, Oligochaeta p. 826.

Chaetae eight per segment. Clitellum developed over six to eleven segments, between xi and xxi. Prostatic pores two pairs, on xvii, xix, not always on papillae. Male pores one pair, on xviii, in seminal grooves. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9. Nephridiopores alternately dorso-lateral

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and ventro-lateral except on the first six to twelve segments. Gizzard single, well developed, anterior to septum viii/ix. Dorsal blood vessel paired or unpaired; three or four pairs of hearts, the last in xiii. Testes two pairs, in x, xi, not in testis sacs. Vesiculae seminales always present in xi, xii, sometimes also in ix or x, or ix and x. Prostates two pairs, with ducts opening to the exterior in xvii, xix, each usually confined to a single segment. Penial chaetae usually present (lacking in only one species, *M. ultimus*). Copulatory muscles usually lacking (present in one species, *M. alpinus*). Spermathecae two pairs, in viii, ix; diverticula rarely lacking (in two species), otherwise with small number of diverticula, frequently one projecting through the septum into the next anterior segment. Nephridial vesicles usually present, sometimes absent.

Type species: *Maoridrilus dissimilis* (Beddard)

Number of Species: Twenty-five.

Distribution: New Zealand; southern North Island and South Island. (Fig. 363).

The genus was established by Michaelsen (1899) for species, formerly included in *Acanthodrilus,* which have the nephridiopores alternately dorso-lateral and ventro-lateral in successive segments.

Fourteen new species, *M. alpinus, M. carnosus, M. fuscus, M. gravus, M. minor, M. montanus, M. nelsoni, M. pallidus, M. ruber, M. rubicundus, M. transalpinus, M. ultimus, M. volutus,* and *M. wilkini,* are described in this volume. Three species that have been ascribed by previous workers to the genus are regarded as *species incertae sedis.*

KEY TO THE SPECIES OF MAORIDRILUS

a1 Gizzard confined to v
  b1 Dorsal blood vessel unpaired
    c1 Vesiculae seminales two pairs, in xi, xii ..... **M. alpinus**
    c2 Vesiculae seminales four pairs, in ix, x, xi, xii ..... **M. smithi**
  b2 Dorsal blood vessel paired, but two vessels fusing at septa
    d1 Spermathecal diverticula absent ..... **M. gravus**
    d2 Spermatheca with six diverticula opening into anterior and lateral aspects of duct ..... **M. rubicundus**
a2 Gizzard confined to vi
  e1 Dorsal blood vessel unpaired
    f1 Spermathecal diverticula absent ..... **M. minor**
    f2 Spermatheca with one or two diverticula
      g1 Oesophageal glands two pairs
        h1 Oesophageal glands in xiv, xv; spermatheca with one small ovoidal diverticulum ..... **M. volutus**
        h2 Oesophageal glands in xvi, xvii; spermatheca with two small, rounded, pustulate diverticula ..... **M. dissimilis**
      g2 Oesophageal glands three pairs, in xiv, xv, xvi
        i1 Vesiculae seminales two pairs, in xi, xii ..... **M. megacystis**
        i2 Vesiculae seminales three pairs, in x, xi, xii ..... **M. transalpinus**
      g3 Oesophageal glands four pairs, in xiii, xiv, xv, xvi ..... **M. wilkini**
  e2 Dorsal blood vessel paired for all or part of its length; the two vessels fuse at each septum
    j1 Dorsal blood vesse! paired only anterior to prostatic region, unpaired posteriorly
      k1 Penial chaetae absent ..... **M. ultimus**
      k2 Penial chaetae present
        l1 Oesophageal glands one pair, in xiv ..... **M. suteri**
        l2 Oesophageal glands two pairs, in xiv, xv ..... **M. purus**

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j_2 Dorsal blood vessel paired for all or most of its length
m_1 Oesophageal glands two pairs
n_1 Oesophageal glands in xiv, xv; spermathecae with one small, rounded, anterior diverticulum, in same segment as sac ..... **M. plumbeus**
n_2 Oesophageal glands in xv, xvi; spermathecae with one small, rounded, anterior diverticulum, projecting through septum into adjacent anterior segment ..... **M. fuscus**
m_2 Oesophageal glands three pairs, in xiv, xv, xvi
o_1 Vesiculae seminales in the form of lobed sacs; hearts connected to dorsal and supra-intestinal blood vessels ..... **M. nelsoni**
o_2 Vesiculae seminales racemose; hearts arising from supra-intestinal vessel only, not connected to dorsal blood vessel ..... **M. uliginosus**
a_3 Gizzard confined to vii or extending through vi–vii or vii–viii
p_1 Dorsal blood vessel unpaired
q_1 Oesophageal glands absent ..... **M. pallidus**
q_2 Oesophageal glands present
r_1 Oesophageal glands two pairs, in xiv, xv; spermatheca with two diverticula ..... **M. modestus**
r_2 Oesophageal glands three pairs, in xiv, xv, xvi; spermatheca with two diverticula ..... **M. parkeri**
r_3 Oesophageal glands four pairs, in xiii, xiv, xv, xvi; spermatheca with one diverticulum ..... **M. michaelseni**
p_2 Dorsal blood vessel paired only in viii–xvi, the two vessels fusing at each septum, otherwise unpaired ..... **M. carnosus**
p_3 Dorsal blood vessel paired from pharynx to posterior end, but two vessels fusing at each septum
s_1 Vesiculae seminales two pairs, in xi, xii
t_1 Spermatheca with single diverticulum divided into several small lobes, opening into anterior aspect of spermathecal duct, in same segment as spermathecal sac ..... **M. montanus**
t_2 Spermatheca with small, round, pustulate, anterior diverticulum, projecting through septum into adjacent anterior segment ..... **M. ruber**
s_2 Vesiculae seminales four pairs, in ix, x, xi, xii ..... **M. tetragonurus**

The species of *Maoridrilus* form a very compact group, and individual species are distinguishable only by small differences in their internal anatomy (see Table 10). It is not possible to distinguish groups of species that could be regarded as significant on anatomical grounds, but certain relationships may be inferred from the present geographical distribution of the species (see Fig. 362) when considered in the light of their ecological requirements and the recent geological and climatic history of New Zealand.

There is a concentration of species in the southern end of the North Island and the northern end of the South Island. In this region the species generally have very small distributional ranges, and they are all closely related in their anatomical features. A number of species are found on the eastern side of the South Island, and the distribution of those species is comparatively wide. A few species are found in isolated localities in north-west and central districts of the North Island and a few in the west and south-west of the South Island.

Maoridrilus is predominantly a forest-dwelling genus and most of its species are now found in beech forests or in soils that were originally formed under beech forests. A few species are found in tussock grassland soils on the east side of the South Island, but with two exceptions (*M. alpinus* and *M. dissimilis*) they are also found in forest soils, and it is possible that further collecting would show that these two species are also found in forest soils. It is therefore reasonable to assume that the genus has probably achieved most of its

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TABLE 10. Maoridrilus

——	*alpinus*	*carnosus*
Length	74 mm.	144 mm.
Diameter	4 mm.	6 mm.
Segments	187	252
Colour	reddish brown	orange brown
Clitellum	xiv–xx	xiii–xix
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	tanylobous
Prostatic papillae	prominent, domed	prominent, domed
Position of prostatic pores	a	a/b
Position of male pores	anterior to a/b in seminal grooves	a/b in seminal grooves
Position of female pores	anterior to a	antero-medial to a
Position of spermathecal pores	7/8, 8/9 a/b	7/8, 8/9 a/b
Position of nephridiopores	b–c	b–c
1st ventral nephridiopore	vii	xiii
Septal thickening	viii/ix–xiii/xiv	viii/ix–xiii/xiv
Proventriculus	absent	vi
Gizzard	v	vii
Nature of gizzard	long, strong	large, strong
Oesophageal glands	xiv, xv, xvi	xiv
1st intestinal segment	xviii	xviii
Dorsal blood vessel	unpaired	paired in viii–xvi, otherwise unpaired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	supra-intest. b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii sac	xi, xii racemose
Penial chaetae	present	present
Copulatory muscles	present	absent
Spermathecal diverticula:		
Number	1	1
Form	small pyriform	large, irregularly lobed
Position	anterior, in next anterior segment	anterior, in next anterior segment
Nephridial vesicles	present	present

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TABLE 10. Maoridrilus—*continued*

dissimilis	*fuscus*	*gravus*	*megacystis*
120 mm.	221 mm.	51 mm.	90 mm.
6·5 mm.	11 mm.	3 mm.	5 mm.
199	210	102	230
brick red	brown	grey	greyish purple
xiv–xix	½xiv–½xx	xii–xix	xiii–xxi
dorsal and lateral	dorsal and lateral	complete	dorsal and lateral
tanylobous	tanylobous	tanylobous	tanylobous
prominent, conical	small, rounded	absent	small
a/b	a/b	a	medial to a
a/b	a/b	a/b	medial to a
in seminal grooves	in seminal grooves	in seminal grooves	in seminal grooves
antero-lateral to b	antero-medial to b	antero-lateral to a	anterior to b
7/8, 8/9 b	7/8, 8/9 b	7/8, 8/9 b	7/8, 8/9 a
b-c	b–c	b–c	b–c
x	xi	xii	?
vii/viii–xiv/xv	vi/vii–xv/xvi	absent	viii/ix–xiii/xiv
v	v	absent	v
vi	vi	v	vi
long, strong	long, strong	large, strong	strong
xvi, xvii	xv, xvi	xiv, xv	xiv, xv, xvi
xviii	xviii	xvii	xvii
unpaired	paired post. to xii/xiii, fusing at septa	paired post. to ix/x, fusing at septa	unpaired
4	4	4	4
xiii	xiii	xiii	xiii
supra-intest. b.v.	dorsal b.v.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii	xi, xii
racemose	racemose	racemose	racemose
present	present	present	present
absent	absent	absent	absent
2	1	absent	1
small, rounded, pustulate	small, rounded, pustulate	..	ovoidal
anterior, in next anterior segment	anterior, in next anterior segment	..	anterior, in next anterior segment
present	present	present	present

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TABLE 10. Maoridrilus—*continued*

	michaelseni	*minor*
Length	90–140 mm.	27 mm.
Diameter	3 mm.	1·5 mm.
Segments	130	104
Colour	brownish green	brown
Clitellum	xiii–xix	½xiii–xix
Extent of clitellum	dorsal and lateral	complete
Prostomium	tanylobous	tanylobous
Prostatic papillae	rounded	prominent, rounded
Position of prostatic pores	a/b	a/b
Position of male pores	a/b	a/b
Position of female pores	in seminal grooves a	in seminal grooves antero-medial to b
Postion of spermathecal pores	7/8, 8/9 a	7/8, 8/9 a
Position of nephridiopores	a–d	a–c
1st ventral nephridiopore	xi	x
Septal thickening	viii/ix–xiii/xiv	absent
Proventriculus	?	v
Gizzard	vi–vii	vi
Nature of gizzard	long, strong	narrow, strong
Oesophageal glands	xiii, xiv, xv, xvi	xv, xvi
1st intestinal segment	xviii	xviii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	4
Last heart	xiii	xiii
Origin of hearts	supra-intest. b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii sac	xi, xii racemose
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	absent
Form	small, club shaped	..
Position	anterior, in next anterior segment	..
Nephridial vesicles	?	present

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TABLE 10. Maoridrilus—*continued*

modestus	*montanus*	*nelsoni*	*pallidus*
106 mm.	350–700 mm.	156 mm.	74 mm.
3·5–5·5 mm.	15–40 mm.	6·5 mm.	3·5 mm.
153	200–300	227	186
grey	dark brown	red	pink
xiii–xx	½xi–xxi	..	xiv–xx
dorsal and lateral	dorsal and lateral	..	dorsal and lateral
tanylobous	tanylobous	tanylobous	tanylobous
prominent	prominent, round	small, rounded	small, rounded
a/b	b	b	a/b
a/b, in	a/b, in	a/b, in	a/b, in
seminal grooves	seminal grooves	seminal grooves	seminal grooves
anterior to b	antero-lateral to a	anterior to b	antero-lateral to b
ant. margins of	7/8, 8/9	7/8, 8/9	7/8, 8/9
viii, ix. b	b	a/b	a/b
b–c	b–c	b–c	b–c
xiii	xi	x	xii
vii/viii–xiii/xiv	ix/x–xiii/xiv	ix/x–xiv/xv	ix/x–xii/xiii
v–vi (or v)	vi	v	vi
vii (or vi–vii)	vii–viii	vi	vii
long, strong	large, strong	long, strong	strong
xiv, xv	absent	xiv, xv, xvi	absent
xviii	xiv	xviii	xviii
unpaired	paired post. to iv/v, fusing at septa	paired post. to xii/xiii, fusing septa	unpaired
4	4	4	4
xiii	xiii	xiii	xiii
dorsal b.v.	dorsal b.v.	dorsal and supra-intest. b.vv.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii	xi, xii
racemose	racemose	lobed sacs	racemose
present	present	present	absent
absent	absent	absent	absent
2	1	1	1
globular	lobed	small, ovoidal, irregular	irregular, spheroidal
anterior	anterior	anterior, in next anterior segment	lateral
present on dorsal nephridia, absent on ventral.	present	present	present

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TABLE 10. Maoridrilus—*continued*

——	*parkeri*	*plumbeus*
Length	184 mm.	27 mm.
Diameter	9 mm.	2 mm.
Segments	185	98
Colour	?	dark brownish grey
Clitellum	xiii–xix	xii–xix
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	prolobous	epilobous
Prostatic papillae	present	small, rounded
Position of prostatic pores	a/b	a/b
Position of male pores	a/b in seminal grooves	a/b seminal grooves
Position of female pores	?	anterior to b
Position of spermathecal pores	7/8, 8/9 ?	7/8, 8/9 a
Position of nephridiopores	?	b–c
1st ventral nephridiopore	?	xi
Septal thickening	vii/viii–xvi/xvii	absent
Proventriculus	v?	v
Gizzard	vi–vii	vi
Nature of gizzard	strong	strong
Oesophageal glands	xiv, xv, xvi	xiv, xv
1st intestinal segment	xviii	xvii
Dorsal blood vessel	unpaired	paired post. to xii/xiii, fusing at septa
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	supra-intest. v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	xi, xii sac
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	2	1
Form	mulberry shaped	small, round
Position	?	anterior
Nephridial vesicles	present	present

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TABLE 10. Maoridrilus—*continued*

purus	*ruber*	*rubicundus*	*smithi*
130–140 mm.	121 mm.	61 mm.	75 mm.
6–7 mm.	7·5 mm.	4·5 mm.	3 mm.
180	207	93	114
dark brown	purplish red	brick red	dark brown
(½xiii) xiv–xix	xiii–xx	xiii–xx	xiii–xix
dorsal and lateral tanylobous	dorsal and lateral tanylobous	dorsal and lateral epilobous	dorsal and lateral tanylobous
large	small, rounded	low, rounded	small, rounded
a/b	a/b	b	a/b
a/b	a/b	a/b	antero-lateral to a,
in seminal grooves anterior to a	in seminal grooves anterior to b	in seminal grooves antero-medial to a	in seminal grooves ?
7/8, 8/9 a/b	7/8, 8/9 b	7/8, 8/9 b	7/8, 8/9 b
b–d	b–c	c–d	b–c
xi	xiii	vii	?
vi/vii–xv/xvi	x/xi–xvi/xvii	absent	?
v	v–vi	absent	absent
vi	vii–viii	v	v
strong	large, strong	long, strong	very small
xiv, xv	xv, xvi	xiv	xiv, xv
xviii	xviii	xvii	xviii
paired ant. to xvi/xvii or xvii/xviii, fusing at septa	paired post. to iv/v, fusing at septa	paired, fusing at septa	unpaired
4	**4**	**3**	**4**
xiii	xiii	xii	xiii
supra-intest. v	supra-intest. v.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
xi, xii	xi, xii	xi, xii	ix, x, xi, xii
racemose	racemose	botryoidal	racemose
present	present	present	present
absent	absent	absent	absent
1	**1**	**6**	**3**
small, round	small, round, pustulate	small, spheroidal	small, pyriform
anterior	anterior in next anterior segment	anterior and lateral	1 in next anterior seg. 2 in spermathecal seg.
present	present	present	present

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TABLE 10. Maoridrilus—*continued*

——	*suteri*	*tetragonurus*
Length	140 mm.	160–280 mm.
Diameter	7 mm.	8–10 mm.
Segments	160	c. 200
Colour	pale grey	greyish violet
Clitellum	xiv–xix	xii–xx
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	tanylobous
Prostatic papillae	low, rounded	low, rounded
Position of prostatic pores	a/b	a
Position of male pores	a/b in seminal grooves	medial to a in seminal grooves
Position of female pores	?	anterior to a/b
Position of spermathecal pores	7/8, 8/9 a/b	7/8, 8/9 a
Position of nephridiopores	a/b–c/d	b–c/d
1st ventral nephridiopore	?	xi
Septal thickening	vi/vii–xiv/xv	vii/viii–xvi/xvii
Proventriculus	v?	vi?
Gizzard	vi	vii
Nature of gizzard	large, strong	large, strong
Oesophageal glands	xiv	xiv, xv, xvi, xvii
1st intestinal segment	?	xx
Dorsal blood vessel	paired in x–xiv, fusing at septa, otherwise unpaired	paired, fusing at septa
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii botryoidal	ix, x, xi, xii: ix, x sac; xi, xii racemose
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	1
Form	small, rounded, pustulate	spheroidal
Position	anterior	anterior
Nephridial vesicles	?	?

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TABLE 10. Maoridrilus—*continued*

transalpinus	*uliginosus*	*ultimus*
163 mm.	200–225 mm.	91 mm.
·5·5 mm.	9 mm.	5 mm.
231	130–230	210
light brown	reddish brown	pink
..	xiv–xix	xiii–xx
..	dorsal and lateral	dorsal and lateral
tanylobous	tanylobous	tanylobous
small	small, round	absent; pores in grooves
a/b	a	b
a/b	a/b	a/b
in seminal grooves	in seminal grooves	in seminal grooves
antero-medial to b	anterior to b	antero-lateral to a
7/8, 8/9 a/b	7/8, 8/9 a/b	7/8, 8/9 a
b–c	b–c	b–c
x	xi (or xii)	x
ix/x–xii/xiii	viii/ix–xii/xiii	vii/viii–xiv/xv
v	v	v
vi	vi	vi
long, strong	large, strong	large, strong
xiv, xv, xvi	xiv, xv, xvi (or xiii, xiv, xv)	xv
xviii	xviii	xviii
unpaired	paired, fusing at septa	paired in vii–xv, fusing at septa; otherwise unpaired
4	4	4
xiii	xiii	xiii
supra-intest. b.v.	supra-int. b.v.	supra-int. b.v.
x, xi	x, xi	x, xi
x, xi, xii	xi, xii	xi, xii
sac	racemose	racemose
present	present	absent
absent	absent	absent
1	1	1
flat with ridged surface	small, round, pustulate	spirally coiled, narrow, tubular
anterior, in next anterior segment	anterior; sometimes in next anterior segment	anterior, in next anterior segment
absent	present	present

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TABLE 10. Maoridrilus—*continued*

—— .	*volutus*	*wilkini*
Length	108 mm.	110 mm.
Diameter	4·75 mm.	4 mm.
Segments	238	179
Colour	light brown	brick red
Clitellum	½xiii–½xx	xiv–xix
Extent of clitellum	dorsal and lateral	dorsal and lateral
Prostomium	tanylobous	tanylobous
Prostatic papillae	small, round	absent
Position of prostatic pores ..	a	a/b
Position of male pores ..	medial to a in seminal grooves	a/b in seminal grooves
Position of female pores ..	anterior to b	antero-medial to a
Position of spermathecal pores ..	near anterior margins of viii, ix; a	anterior margins of viii, ix; a/b
Position of nephridiopores ..	b–c	b–c
1st ventral nephridiopore ..	xi	x
Septal thickening	viii/ix–xiv/xv	ix/x–xii/xiii
Proventriculus	v	absent
Gizzard	vi	vi
Nature of gizzard	long, strong	very large, strong
Oesophageal glands	xiv, xv	xiii, xiv, xv, xvi
1st intestinal segment ..	xviii	xviii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	4	4
Last heart	xiii	xiii
Origin of hearts	supra-int. b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	ix, xi, xii sac
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	1
Form	small, ovoidal	small, club shaped
Position	anterior, in next anterior segment	anterior, in next anterior segment
Nephridial vesicles	present	present

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present distribution pattern under a forest vegetation, so any changes during Pleistocene or recent times in the distribution of forests would have had an important bearing on the present distribution of the genus.

Willett (1950, p. 33), from geological and botanical evidence, mapped the probable boundaries of the glacial ice and surrounding tundra, steppe, and forest regions in New Zealand during the Pleistocene glaciation. He considered that most of the North Island and the northern extremity of the South Island were forested, while ice covered much of the mountain areas of the South Island and extended to the sea over the present coastal plain of the West Coast, and the areas east and north-west of the ice were tundra and steppe lands, probably with isolated pockets of forest.

Cotton and Te Punga (1955), on geological evidence, considered that periglacial conditions, which would inhibit the growth of forest, existed over a considerable portion of the south-west of the North Island, right down to sea level.

Te Punga (1953) suggested that during most of Pleistocene time a land connection existed across Cook Strait, and that the last remnant of this connection probably persisted until about 11,000 years ago.

Further north, during Pleistocene times, there was intense volcanic activity, and volcanic ash beds and lavas covered central districts of the North Island from west coast to east coast; the deposition of this volcanic material must have destroyed much of the vegetation and profoundly affected the soil fauna. Ash showers have continued into very recent time.

When the present distribution of *Maoridrilus* is considered in relation to these geological and associated vegetational changes, the following points emerge:

Before glaciation and volcanic activity modified its distribution, *Maoridrilus* was probably widely distributed in forested country in the South Island and the south and west of the North Island. The change in the vegetation in the South Island from forest to tundra, which resulted from the lower temperatures during glaciation, would have eliminated *Maoridrilus* from all but the forested areas in the north of the island and from isolated pockets of forest in the east and south-west. Some forested areas must have remained in the south-west, probably close to the coast on ridges between valley glaciers, since a characteristic forest fauna, including genera other than *Maoridrilus*, remains in this area, and the west coast plain of the South Island, which was covered by an ice sheet extending down to the sea is bounded on the south by beech forest, which is apparently advancing northward onto the area formerly covered by ice. Te Punga's hypothesis of a recent land connection across Cook Strait adequately explains the close relationships that exist between the species of the south of the North Island and the north of the South Island, provided that these regions were forested during the Pleistocene glaciation. The distribution of vegetation during glaciation put forward by Willett (1950) suits the facts of earthworm distribution more closely than does that put forward by Cotton and Te Punga (1955). When the glaciers retreated and forest advanced over much of the South Island, species of *Maoridrilus*

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would have spread out into the forest soils. A few species have moved into the extensive tussock grassland soils of the east side of the South Island. Because it is such a short time since these species moved into this region, and as there were probably no earthworms there before, the distributional range of individual species is now much wider than that of a typical species from the north of the South Island, where forest apparently persisted during glaciation. The position is comparable to that of the few species of *Rhododrilus* which have apparently invaded the area covered by the Taupo ash shower during the last 1,700 years. Species in the north-west of the North Island (*M. plumbeus* and a species described under the name of *M. mauiensis,* but listed here as a *species incertae sedis*) probably represent isolated remnants of a former wider distribution of the genus in the North Island. The isolation of these species has probably been due to the extinction of other species as a result of volcanic activity.

To sum up, apart from a few isolated species in the north-west of the North Island and the south-west of the South Island, the species of *Maoridrilus* have spread out from a centre in the vicinity of Cook Strait, where they were isolated by vegetational changes consequent on changes in climate during the Pleistocene glaciation of the New Zealand region. Most, if not all, of the species inhabit forest soils, and their present distribution can best be explained by a series of changes during and following the glaciation. The extent of forest during the late Pleistocene must have been wider than Cotton and Te Punga (1955) suppose, and more like that put forward by Willett (1950). The presence until very recently of a land connection across Cook Strait would explain the close similarity between species north and species south of the strait and on the islands in the strait. The absence of great differences in the anatomy and morphology of the species is a result of the very recent spreading of species across large areas uninhabitable during the last glaciation. There has been insufficient time for the differentiation of new species since the previously uninhabited areas were re-populated. The present situation in the east of the South Island is comparable to that of the re-population of the region covered by the Taupo ash shower by species of *Rhododrilus,* (q.v.).

Maoridrilus alpinus n.sp. Figs. 172–176

Length 74 mm. Diameter 4 mm. 187 segments; all except i and the clitellar segments triannulate.

Colour reddish brown with pink clitellum.

Clitellum xiv–xx, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment; bc>dd>aa≫ab>cd.

Prostatic pores on prominent papillae on xvii, xix, in position of chaeta a.

Male pores in seminal grooves on xviii, slightly anterior to chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

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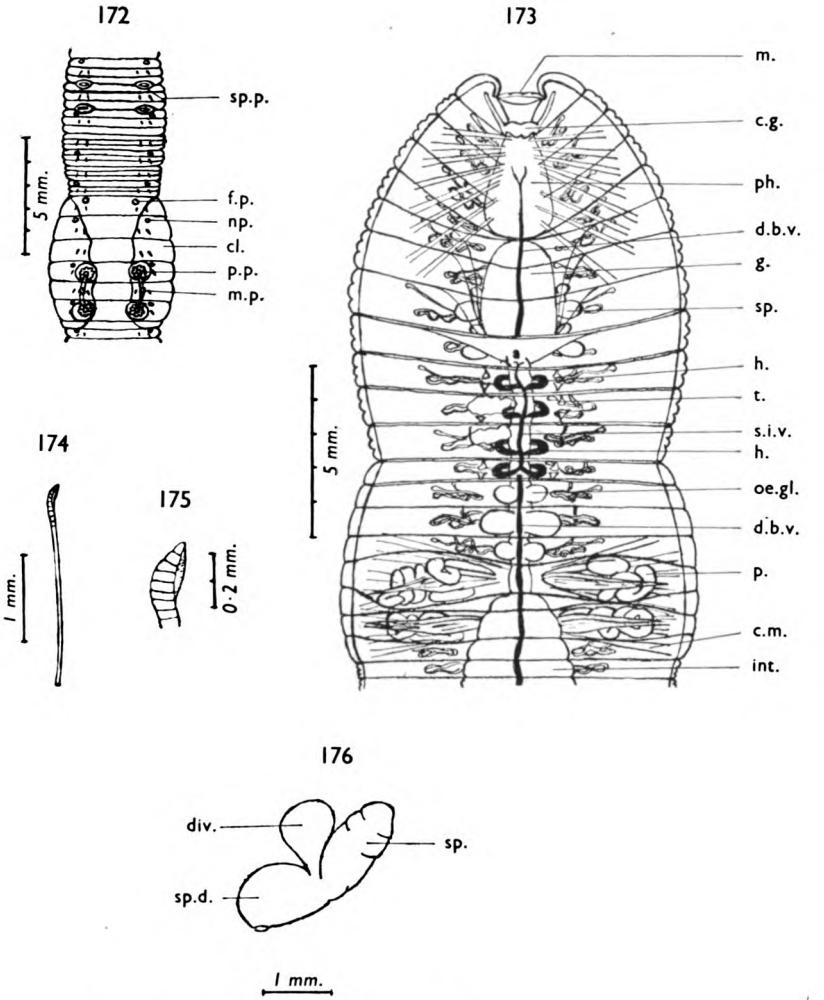
Nephridiopores of ii anterior to chaeta d, of iii–vi anterior to chaeta c, of vii anterior to chaeta b; posterior to vii alternating between position c and position b.

Septa viii/ix to xiii/xiv thickened.

Pharynx in i–iv. Gizzard in v, long and strongly muscular. Oesophageal glands in xiv, xv, xvi; those of xv larger than those of xiv and xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.



FIGS. 172–176. *Maoridrilus alpinus* n.sp.
172. Ventral aspect, segments viii–xx
173. Dissection from dorsal aspect, segments i–xxi
174. Penial chaeta
175. Tip of penial chaeta
176. Right anterior spermatheca, anterior aspect

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Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, sac-like, curved, cylindrical. Prostates in xvii, xix, long, coiled, tubular. Penial chaetae in paired sacs medial to each prostate; slightly curved, short, thick spine with a recurved, swollen, spoon-shaped tip; small ridges encircle shaft near tip (Figs. 174, 175). Copulatory muscles present in prostatic segments. Spermathecae in viii, ix; small ovoidal sac opening into large muscular atrium, larger than sac; small pyriform diverticulum projects through septum into adjacent anterior segment and opens by short narrow duct into atrium; atrium opens to exterior through very short wide duct. (Fig. 176).

Nephridia with minute vesicles.

Type Locality: Lindis Pass, Otago; 3,900 ft.; topsoil, snow tussock; K.E.L., 11/10/53.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 4 specimens.
Lindis Pass, Otago, 4,000 ft.; topsoil, snow tussock; K.E.L., 21/10/53; 9 specimens.

Maoridrilus carnosus n.sp. Figs. 177–180

Length 144 mm. Diameter 6 mm. 252 segments; all except i and ii biannulate.

Colour—dorsal surface orange-brown anteriorly, light brown posteriorly, pale ventral surface; narrow red-brown streak runs from clitellum to anus along dorsal mid line; clitellum reddish orange.

Clitellum xiii–xix, dorsal and lateral.

Posterior to clitellum the body is almost square in cross section with the pairs of chaetae on the corners of the square in each segment.

Prostomium tanylobous.

Chaetae 8/segment; ab=cd; dd>bc>aa ≫ ab.

Prostatic pores on prominent papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores anterior to chaeta d on ii, to c on iii–xii, to b on xiii, alternating between c and b positions posterior to xiii.

Septa viii/ix to xiii/xiv thickened.

Pharynx in i–v, elongate. Proventriculus in vi, short, thin walled. Gizzard in vii, large, strongly muscular. Oesophageal glands in xiv. Intestine commences in xviii.

Dorsal blood vessel unpaired anterior to vii/viii; paired in viii–xvi, but the two vessels fuse at each septum; unpaired posterior to xvi/xvii. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi, consisting of a number of thread-like processes. Ovaries in xiii; thin folded lamina. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, coiled and tubular, of large size. Penial chaetae in sacs lateral to prostates; short, stout, curved shaft, more

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sharply curved near tip, sharply pointed (Fig. 179). Spermathecae in viii, ix; large, irregular, ovoidal sac with long wide duct; large, irregular, lobed diverticulum projects through septum into adjacent anterior segment and opens by short duct into spermathecal duct. (Fig. 180).

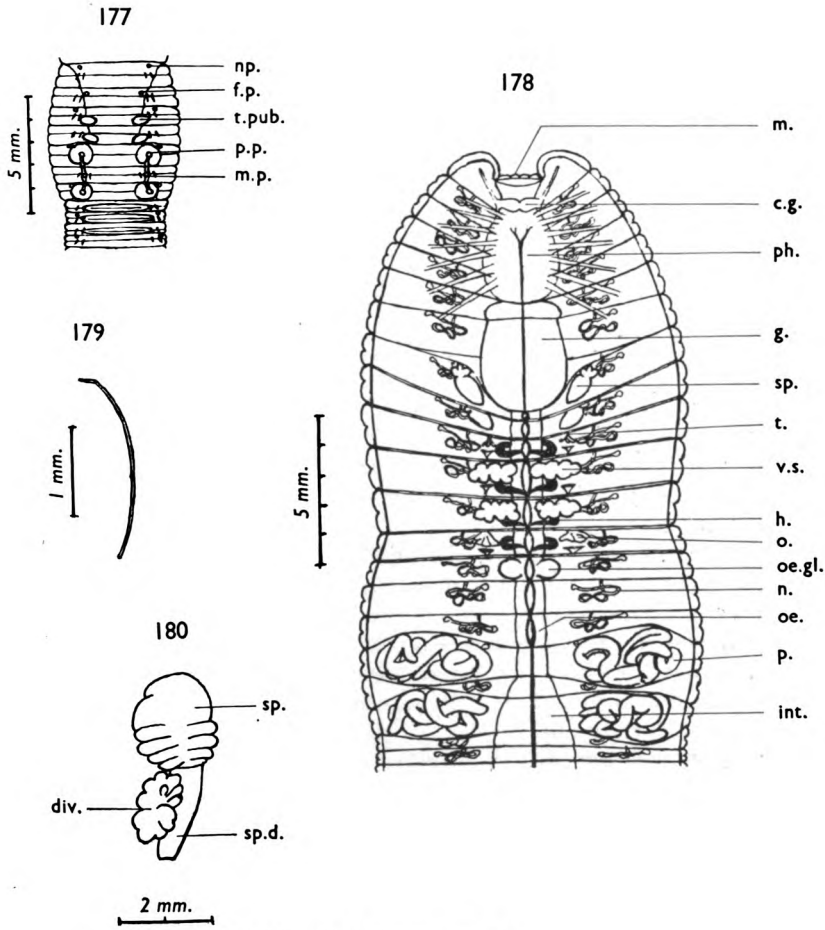
Nephridia with small vesicles.

Type Locality: Lake Ferry, S. Wairarapa; topsoil in rough pasture above sea cliffs; K.E.L., 30/8/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Tuhitarata, Wairarapa; topsoil, manuka scrub; K.E.L., 30/8/49; 2 specimens. Rimutaka Ra., near summit



FIGS. 177–180. *Maoridrilus carnosus* n.sp.
177. Ventral aspect, segments xiii–xxiii
178. Dissection from dorsal aspect, segments i–xxi
179. Penial chaeta
180. Right posterior spermatheca, medial aspect

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of main road on Wairarapa side; topsoil, pasture; K.E.L., 19/4/50; 5 specimens. Tauherenikau, Wairarapa; topsoil, broadleaved forest; K.E.L., 19/4/50; 1 specimen. Mikimiki, Wairarapa; topsoil, manuka scrub; K.E.L., 20/4/50; 2 specimens. Keith George Memorial Park, Silverstream, Hutt Valley; topsoil, broadleaved forest; K.E.L., 24/4/51; 2 specimens. Cliff top, Mana Id.; topsoil, rough pasture; M. L. Leamy, 29/9/54; 7 specimens. Mangawhahariki Gorge, near Mangaweka; topsoil, forest; K.E.L., 13/10/50; 10 specimens.

Maoridrilus dissimilis (Beddard). Figs. 181–183

1885 *Acanthodrilus dissimilis* Beddard, Proc. zool. Soc. Lond., 1885, p. 813.
1886 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1886, p. 169.
1886 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1886, p. 307.
1886 *Acanthodrilus neglectus,* Beddard, Proc. roy. Soc. Edinb. 14:156.
1887 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1887, p. 387.
1889 *Acanthodrilus dissimilis,* Beddard, Quart. J. micr. Sci. 29:105.
1889 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1889, p. 378.
1890 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1890, p. 59.
1890 *Acanthodrilus dissimilis,* Beddard, Quart. J. micr. Sci. 30:425.
1890 *Acanthodrilus dissimilis,* Benham, Quart. J. micr. Sci. 31:230.
1890 *Acanthodrilus neglectus* (= *A. dissimilis*?), Benham, Quart. J. micr. Sci. 31:230.
1891 *Acanthodrilus dissimilis, Acanthodrilus neglectus,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Acanthodrilus dissimilis,* Beddard, Proc. zool. Soc. Lond., 1892, p. 667.
1893 *Acanthodrilus dissimilis,* Smith, Trans. N.Z. Inst. 25:115.
1894 *Acanthodrilus assimilis,* Smith, Trans. N.Z. Inst. 26:166.
1895 *Acanthodrilus dissimilis,* Beddard, Monograph p. 531.
1899 *Maoridrilus dissimilis,* Michaelsen, Zool. Jahrb. Syst. 12:234.
1900 *Maoridrilus dissimilis,* Michaelsen, Tierreich 10:124.
1905 *Maoridrilus dissimilis,* Ude, Z. wiss. Zool. 83.
1910 *Maoridrilus dissimilis,* Michaelsen, Mitt. zool. Mus. Hamb. 27:69.
1937 *Maoridrilus dissimilis,* Pickford, Monograph pp. 61, 602.

The original description (Beddard, 1885) was incomplete. The present description is based on specimens collected near Wharanui, eastern Marlborough, and identified by the author as *M. dissimilis.*

Length 120 mm. Diameter 6·5 mm. 199 segments.

Colour brick red dorsally, paler ventrally, with red clitellum.

Clitellum xiv–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; bc>dd>aa⩾ab.

Prostatic pores on very prominent conical papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, slightly anterior and lateral to chaeta b.

Spermathecal pores at 7/8, 8/9, surrounded by very prominent tumid lips, in line with chaeta b.

Nephridiopores anterior to chaeta d on ii, to c on iii–ix, to b on x, thereafter alternating between c and b.

Septa vii/viii to xiv/xv thickened.

Proventriculus in v, wide, thin walled. Gizzard in vi, long and strongly muscular. Oesophagus dilated in xvi, xvii, but no definite glands. Intestine commences in xviii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted, very long. Penial

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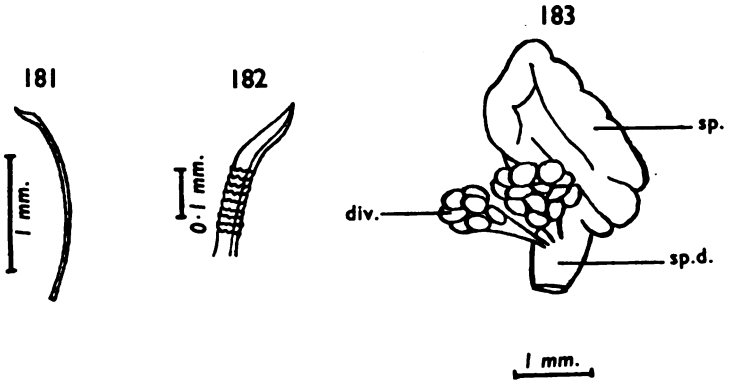

FIGS. 181–183. *Maoridrilus dissimilis*
181. Penial chaeta
182. Tip of penial chaeta
183. Right anterior spermatheca, anterior aspect

chaetae present; short, thick, gently curved spine with small serrated ridges encircling spine near the distal end, sharply curved near tip, tapering to point (Figs. 181, 182). Spermathecae in viii, ix; large irregular sac with short wide duct; two small rounded diverticula with pustulate surfaces, project side by side through septum into next anterior segment and open into spermathecal duct anteriorly. (Fig. 183).

Nephridial vesicles present.

Type Locality: New Zealand (no further details of locality given); F. E. Beddard, 1885.

Type (?) specimen in British Museum (Nat. Hist.), collection registration No. 1904.10.

Remarks: Beddard (1886c) distinguished *Acanthodrilus* (= *Maoridrilus*) *neglectus* from *A. dissimilis* because of a slight difference in the arrangement of the tubercula pubertatis. Since their number and position is variable, the distinction was not upheld, and *M. neglectus* is regarded as a synonym of *M. dissimilis*.

Localities:

South Island: Ridge overlooking Wash Bridge, Wairau Valley; topsoil, *Festuca* tussock; K.E.L., 31/5/54; 1 specimen. Awatere Valley, Marlborough; topsoil, scrub; K.E.L., 30/5/54; 4 specimens. 2 miles S. of Seddon; topsoil, tussock; K.E.L., 29/5/54; 6 specimens. Wharanui; topsoil, stream bank; K.E.L., 29/5/54; 11 specimens. McKenzie Plains, 7 miles S. of Pukaki; subsoil, *Festuca* tussock; K.E.L., 19/10/53; 3 specimens. Alexandra; topsoil, tussock; R. H. Thornton, 10/2/54; 1 specimen. Fraser's Dam Road, Old Man Ra., Central Otago; topsoil, *Poa-Festuca* tussock; K.E.L., 12/10/53; 2 specimens. Fraser's Dam Road; topsoil, scabweed; K.E.L., 12/10/53; 1 specimen. 8 miles S. of Alexandra near Roxburgh; subsoil, pasture; K.E.L., 13/10/53; 1 specimen. Steep slope of gorge above Roxburgh Hydro dam; topsoil, tussock and grasses; K.E.L., 13/10/53; 1 specimen.

Previous Records:

South Island: Canterbury Plains; various authors, 1885 onwards.

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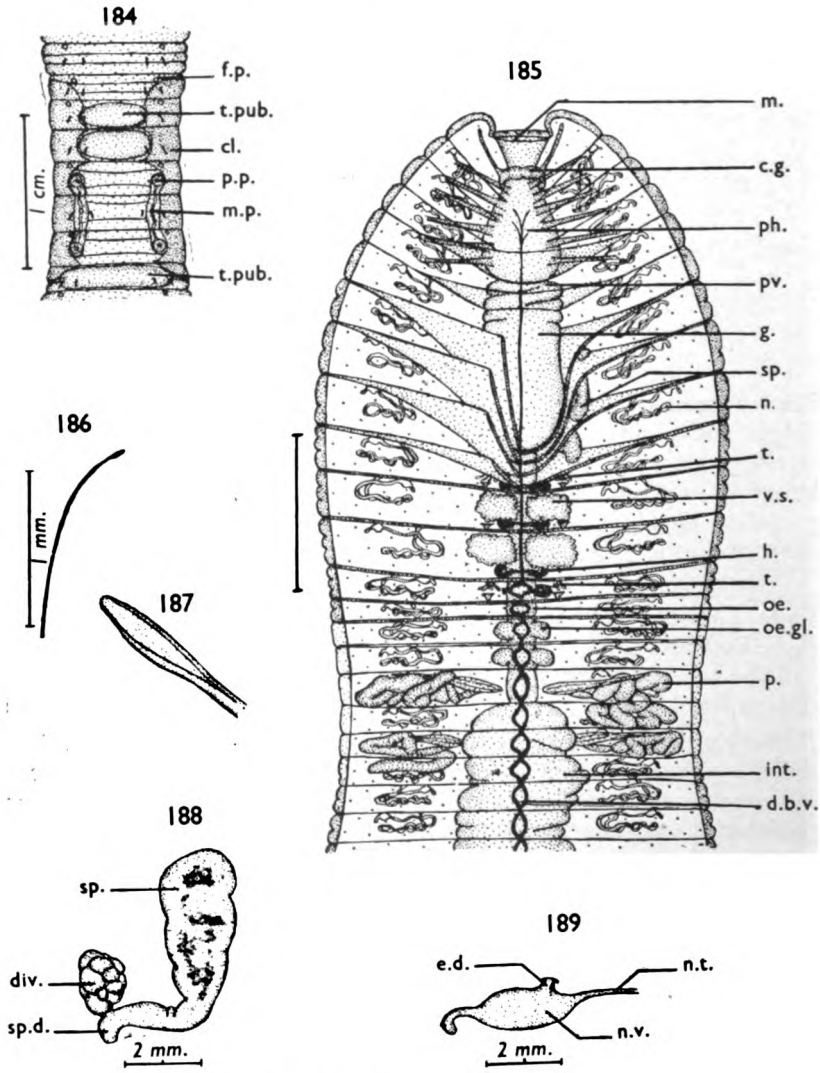
Maoridrilus fuscus n.sp. Figs. 184–189

Length 221 mm. Diameter 11 mm. 210 segments; i–vi without annulations, vii–ix biannulate, x–xiii triannulate, clitellar segments without secondary annulations, post-clitellar segments biannulate.

Colour brown with little differentiation between dorsal and ventral surfaces; clitellum greyish brown.

Clitellum ½xiv–½xx, dorsal and lateral.



FIGS. 184–189. *Maoridrilus fuscus* n.sp.
184. Ventral aspect, segments xiii–xx
185. Dissection from dorsal aspect, segments i–xxii
186. Penial chaeta
187. Tip of penial chaeta
188. Right posterior spermatheca, antero-medial aspect
189. Nephridial vesicle

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Prostomium tanylobous.

Chaetae 8/segment, very closely paired: ab=cd; dd>bc>aa ≫ ab. Each chaeta on a small papilla.

Prostatic pores on small papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior and slightly medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores of ii anterior to chaeta d, iii–x to c, xi to b, thereafter alternating between c and b.

Unpaired, prominent, median ventral tubercula pubertatis are present on xv, xvi and xx; those of xv and xvi occupy the space between chaetae a-a, those of xx occupy the space between chaetae b-b.

Septa vi/vii to xv/xvi thickened.

Pharynx in i–iv, long and pyriform. Proventriculus in v, wide and thin walled. Gizzard in vi, long and thick walled. Oesophageal glands in xv, xvi; in ix there is a pair of small, thin laminar organs, one on each side of the oesophagus, each opening by a narrow duct into the oesophagus. Intestine commences in xviii.

Dorsal blood vessel unpaired anterior to xii/xiii; posterior to xii/xiii the vessel is paired in each segment but the two vessels fuse at each intersegmental septum. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi, each consisting of a number of filiform processes. Ovaries in xiii, each consisting of a number of filiform processes. Vesiculae seminales in xi, xii, racemose. Prostates in xvii (or xvii–xviii), xix (or xix–xx), tubular, convoluted. Penial chaetae in sacs in xvii, xix; long, slender, gently curved shaft with concave, spoon-like tip (Figs. 186, 187). Spermathecae in viii, ix; elongate pyriform sac set at sharp angle to long narrow duct; small rounded diverticulum with pustulate surface lies in adjacent anterior segment and opens by short duct, opening through septum, into spermathecal duct. (Fig. 188).

Nephridial vesicles of unusual form; long and cylindrical with a hook-like curved process projecting from distal end; elimination duct opens from the cylindrical portion close to the junction of the nephridial vesicle and the nephridial tubule, at right angles to the tubule. (Fig. 189).

Type Locality: Ferguson's Bush, near Ross, Westland; subsoil, podocarp-broadleaved forest; K.E.L., 9/1/52.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 3 specimens.

Maoridrilus gravus n.sp. Figs. 190–193

Length 51 mm. Diameter 3 mm. 102 segments.

Colour grey with buff clitellum.

Clitellum xii–xix, complete.

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Prostomium tanylobous.

Chaetae 8/segment, almost equally spaced: aa=ab; bc=cd=dd>aa. Prostatic pores in the centre of small pale areas (not on papillae) on xvii, xix, in line with chaeta a.

Male pores in seminal grooves on xviii, between chaetae a and b (closer to a than to b).

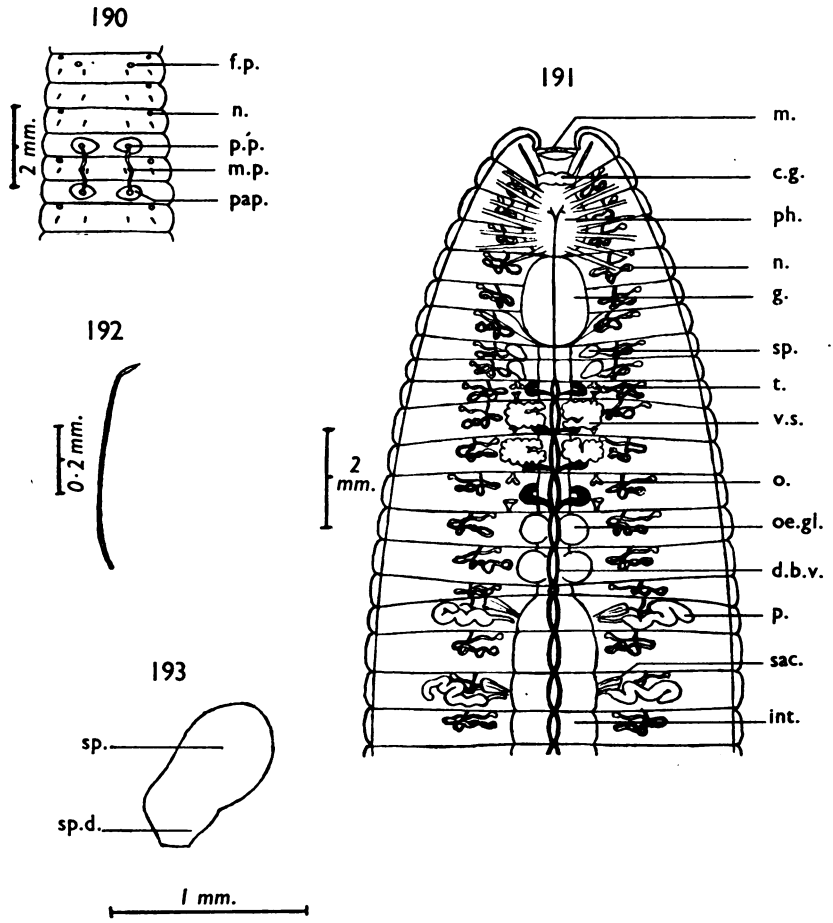
Female pores on xiv, antero-lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores of ii anterior to chaeta d, of iii–xi to chaeta c, of xii to chaeta b, and thereafter alternating between c and b.

No specially thickened septa.

Gizzard in v, large and strongly muscular. Oesophageal glands in xiv, xv, those of xv much larger than those of xiv. Intestine commences in xvii.



FIGS. 190–193. *Maoridrilus gravus* n.sp.
190. Ventral aspect, segments xiv–xx
191. Dissection from dorsal aspect, segments i–xx
192. Penial chaeta
193. Right posterior spermatheca medial aspect

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Dorsal blood vessel unpaired in i–ix; paired in each segment posterior to ix/x, but the two vessels fuse at each intersegmental septum. Hearts from dorsal blood vessels in x, xi, xii, xiii, those of xiii more dilated than those of x–xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae with long, slender, gently curved shaft, sharply bent distally and terminating in a sharp point (Fig. 192). Spermathecae in viii, ix; small, ovoidal sac, slightly swollen near base, opening by very short, wide duct to exterior ; diverticula absent. (Fig. 193).

Nephridia with very small diverticula.

Type Locality: Mt. Ross, S. Wairarapa; ex leaf mould; R. R. Forster, 5/4/47.

Type specimen in Dominion Museum collection.

Localities:

North Island: Same data as type material; 5 specimens. Horopito; ex leaf mould; R. R. Forster, 22/12/48; 3 specimens. Hurleyville; ex leaf mould; D. E. Hurley, 11/1/50; 1 specimen.

Maoridrilus megacystis Benham. Figs. 194, 195

1919 *Maoridrilus megacystis* Benham, Trans. N.Z. Inst. 51:34–41.
1937 *Maoridrilus megacystis,* Pickford, Monograph p. 91.

This species was established by Benham (1919) for a single specimen, which he stated was in a poor state of preservation. It has not been re-collected in the present investigation, but Benham's type material has been re-examined and features of the species which were previously undescribed have been included in the following description. Figs. 194, 195 are copied from Benham.

Length 90 mm. Diameter 5 mm. 230 segments.

Colour greyish purple with red clitellum (in alcohol).

Clitellum xiii–xxi, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc=dd≫ab.

Prostatic pores on xvii, xix, on poorly developed papillae, medial to chaeta a. Seminal grooves present. Male pores in seminal grooves on xviii, medial to chaeta a.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores alternately anterior to chaetae b and c.

Septa viii/ix to xiii/xiv thickened.

Proventriculus in v. Gizzard in vi. Oesophageal glands in xiv, xv, xvi, those of xiv smaller than those of xv, xvi. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; long shaft ornamented near tip with rows of blunt spines

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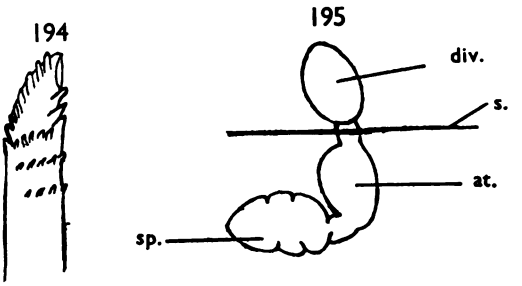

FIGS. 194, 195. *Maoridrilus megacystis*
194. Tip of penial chaeta
195. Left posterior spermatheca, dorsal aspect
(Drawings after Benham, 1919)

and shallow groove (Fig. 194). Spermathecae in viii, ix; each consists of an ovoidal sac with duct, ovoidal diverticulum (in next anterior segment) with duct passing through septum, both ducts opening into large muscular atrium which opens to exterior. (Fig. 195).

Nephridia with long, narrow, tubular vesicles.

Type Locality: Stephen Id.; W. B. Benham, 1919. Type material in Otago Museum (No. A.04.74); 1 specimen, bisected anteriorly, in fair condition.

Maoridrilus michaelseni Ude

1905 *Maoridrilus michaelseni* Ude, Z. wiss. Zool. 83.
1937 *Maoridrilus michaelseni,* Pickford, Monograph p. 91.

Length 90–140 mm. Diameter 3 mm. c. 130 segments.

Colour brownish dorsally, greenish ventrally, with brown clitellum.

Clitellum xiii–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: aa=bc; dd>aa; aa≫ab.

Prostatic pores on xvii, xix, on rounded papillae, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores in line with chaeta d on ii–x, with a on xi, thereafter alternating between d and a.

Septa viii/ix to xiii/xiv slightly thickened.

Gizzard in vi–vii. Oesophageal glands in xiii, xiv, xv, xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, compact. Prostates in xvii, xix, tubular, coiled. Penial chaetae present; curved in sabre-like form, with tip spoon-shaped and covered with very fine close teeth. Spermathecae in viii, ix; slender pyriform sac merging gradually into spermathecal duct; small club-shaped diverti-

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culum in next anterior segment, connected to spermatheca by duct passing through septum.

Type Locality: Westport; H. Ude, 1905.

The type material of this species has not been located.

Localities:

South Island: Kopara Falls, Westland; topsoil, beech forest; K.E.L., 10/1/52; 1 specimen.

Maoridrilus minor n.sp. Figs. 196–199

Length 27 mm. Diameter 1·5 mm. 104 segments.

Colour brown (in alcohol) with pale brown clitellum.

Clitellum ½xiii–xix, complete.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=dd; bc>aa>ab.

Prostatic pores on xvii, xix, on prominent rounded papillae, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior and slightly medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores of ii in line with chaeta d, of iii–ix with chaeta c, of x with chaeta a, thereafter alternating from c to a.

No specially thickened septa.

Pharynx in i–iv. Proventriculus in v. Gizzard in vi; narrow, strong. Oesophageal glands in xv, xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, slightly coiled. Penial chaetae present; long shaft, almost straight, curved near tip and terminating in a point (Fig. 198). Spermathecae in viii, ix; small spherical sac opening to exterior by short narrow duct; no diverticula. (Fig. 199).

Very small nephridial vesicles present.

Type Locality: Mt. Ross, S. Wairarapa; ex moss and lichens; J. T. Salmon, 5/4/47.

Type specimen in Dominion Museum collection.

Localities:

North Island: Same data as type material; 4 specimens.

Maoridrilus modestus Michaelsen. Figs. 200, 201

1910 *Maoridrilus modestus* Michaelsen, Mitt. zool. Mus. Hamb. 27:67–70.
1937 *Maoridrilus modestus,* Pickford, Monograph p. 91.

Length 106 mm. Diameter 3·5–5·5 mm. 153 segments.

Colour grey.

Clitellum xiii–xx, dorsal and lateral.

Prostomium tanylobous.

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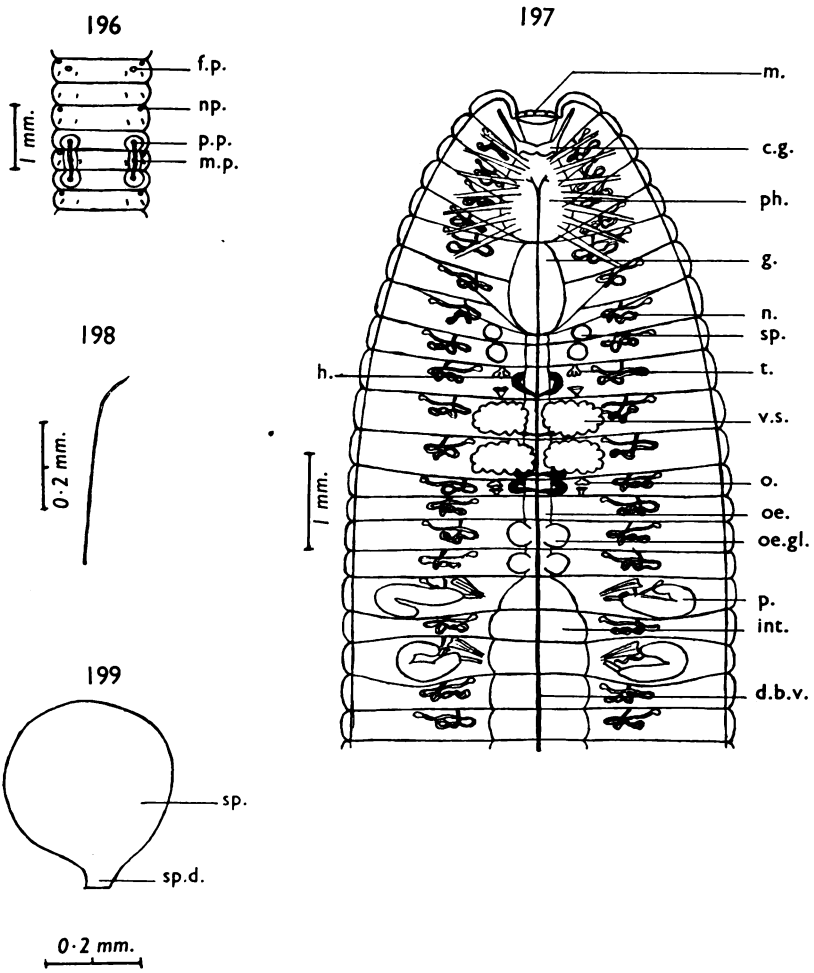

FIGS. 196–199. *Maoridrilus minor* n.sp.
196. Ventral aspect, segments xiv–xx
197. Dissection from dorsal aspect, segments i–xxi
198. Penial chaeta
199. Right posterior spermatheca, medial aspect

Chaetae 8/segment: ab>cd; bc=dd>aa>ab.

Prostatic pores on xvii, xix, on prominent papillae, in line with chaetal interval ab.

Seminal grooves pass between chaetae a and b on xviii.

Male and female pores not visible.

Spermathecal pores at anterior margins of viii and ix, in line with chaeta b.

Nephridiopores alternating more or less regularly between positions anterior to chaetae b and c, except anterior to clitellum, where they are almost all in line with chaeta c.

Septa vii/viii to xiii/xiv thickened.

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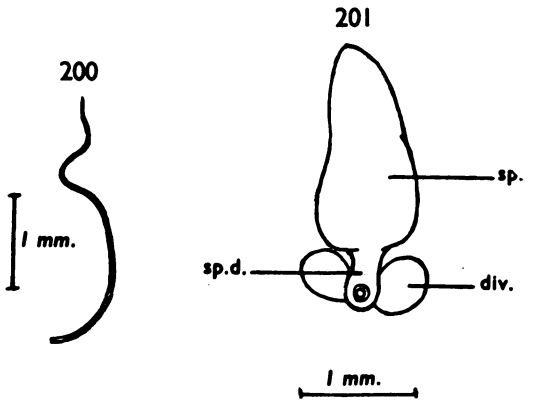

FIGS. 200, 201. *Maoridrilus modestus*
200. Penial chaeta
201. Spermatheca, ventral aspect
(Drawings after Michaelsen, 1910a)

Gizzard in vii (or vi–vii). Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, large, coiled, tubular. Penial chaetae in xvii, xix; elongate curved shaft, distally twisted in a corkscrew fashion (Fig. 200). Spermathecae in viii, ix; long cylindrical sac with short thick duct; two small rounded diverticula open into the duct near its junction with the body wall. (Fig. 201).

Nephridial vesicles present on nephridia that open dorso-laterally, absent on nephridia that open ventro-laterally.

Type Locality: Christchurch (or Dunedin?); W. Michaelsen, 1910.

Type specimen in Zoological Museum, Hamburg.

Localities:

South Island: Hickory Bay, Akaroa; ex leaf mould; R. Pilgrim, 26/1/52; 15 specimens. Kaituna Valley; ex leaf mould; R. R. Forster, 11/9/49; 6 specimens. Kaituna Valley; ex leaf mould; R. Crocker, 10/8/51; 1 specimen. Peel Forest; ex leaf mould; R. R. Forster, 19/1/51; 8 specimens. 6 miles E. of Bealey; topsoil, beech forest; K.E.L., 8/10/53; 2 specimens. 2½ miles W. of Bealey; topsoil, beech forest; K.E.L., 16/10/53; 3 specimens. Mt. Misery, near Bealey, about 100 ft. above forest line; surface shingle, mountain herbs; K.E.L., 9/10/53; 1 specimen. Porters Pass, 3,100 ft.; under moss; K.E.L., 17/10/53; 1 specimen. Porters Pass, 3,100 ft.; leaf mould, mountain shrubs; K.E.L., 17/10/53; 2 specimens. Bluff; under logs; J. Sorensen, 18/5/49; 1 specimen.

Maoridrilus montanus n.sp. Figs. 202–205

Length 350–700 mm. Diameter 15–40 mm. 200–300 segments.

Colour dark brown with paler brown clitellum.

Clitellum ½xi–xxi, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc≫ab; dd>aa.

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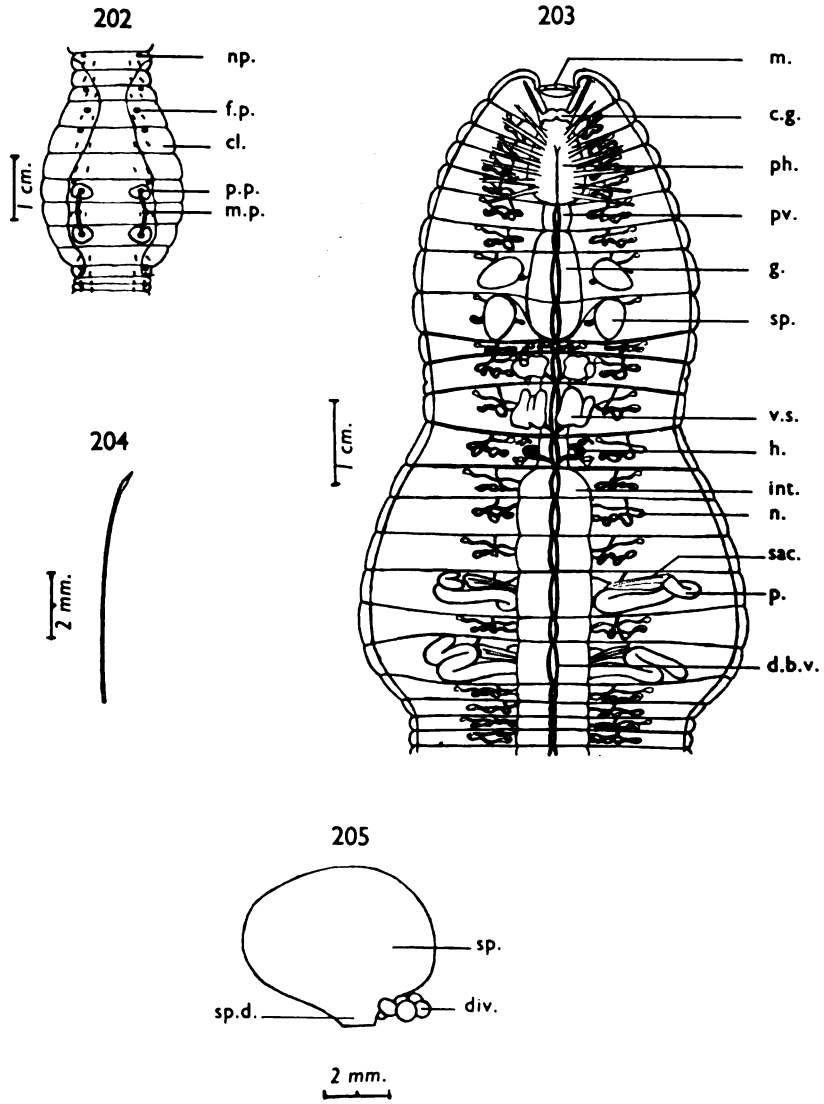
Prostatic pores on xvii, xix, on very prominent papillae, in line with chaeta b.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, slightly anterior and lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, with prominent tumid lips, in line with chaeta b.



FIGS. 202–205. *Maoridrilus montanus* n.sp.
202. Ventral aspect, segments xi–xxiii
203. Dissection from dorsal aspect, segments i–xxiii
204. Penial chaeta
205. Left posterior spermatheca, medial aspect

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Nephridiopores of ii–x in line with chaeta c, of xi with chaeta b, thereafter alternating between chaetae c and b.

Septa ix/x to xiii/xiv thickened.

Pharynx in i–v. Proventriculus in vi, thin walled, not as wide as gizzard. Gizzard in vii–viii; very large and strong. Oesophageal glands absent. Intestine commences in xiv.

Dorsal blood vessel paired posterior to septum iv/v, but the two vessels fuse at each septum. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; elongate, slender shaft, swollen distally and sharply pointed (Fig. 204). Spermathecae in viii, ix; large spherical sac with very short wide duct; small diverticulum, divided into several lobes, opening into anterior aspect of spermathecal duct. (Fig. 205).

Nephridia with small vesicles.

Type Locality: Tararua Ranges, 5,000 ft.; W. B. Benham, 1948.

Type specimen in Dominion Museum collection. Two cotypes in Otago Museum.

Localities:

North Island: Mokai Patea, Ruahine Ra., 3,700 ft.; litter mound of dead tree in forest; A. C. S. Wright, 2/51; 5 specimens.

In addition, fragments of specimens of this very large worm have frequently been sent to me from the Tararua and Southern Ruahine ranges.

Maoridrilus nelsoni n.sp. Figs. 206–210

Length 156 mm. Diameter 6·5 mm. 227 segments.

Colour red dorsally, pale ventrally.

Clitellum not distinguishable.

Prostomium tanylobous.

Chaetae 8/segment: ab>cd; dd>bc>aa≫ab.

Body almost square in cross section posterior to clitellum with chaetae of each segment on the corners of the square.

Prostatic pores on xvii, xix, on papillae, in line with chaeta b.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores of ii dorsal to line of chaeta d, on iii–x lateral, in line with chaeta c, on x in line with chaeta b, posterior to x alternating between c and b.

Large unpaired tuberculum pubertatis on x, across ventral surface; pair of small tubercula on xvi, one on each side, adjacent to prostatic papillae of xvii.

Septa ix/x to xiv/xv thickened.

Pharynx in i–iv, covered with masses of salivary glands. Proventriculus in v, short, thin walled. Gizzard in vi, very long and thick walled. Oesophageal glands in xiv, xv, xvi. Intestine commences in xviii.

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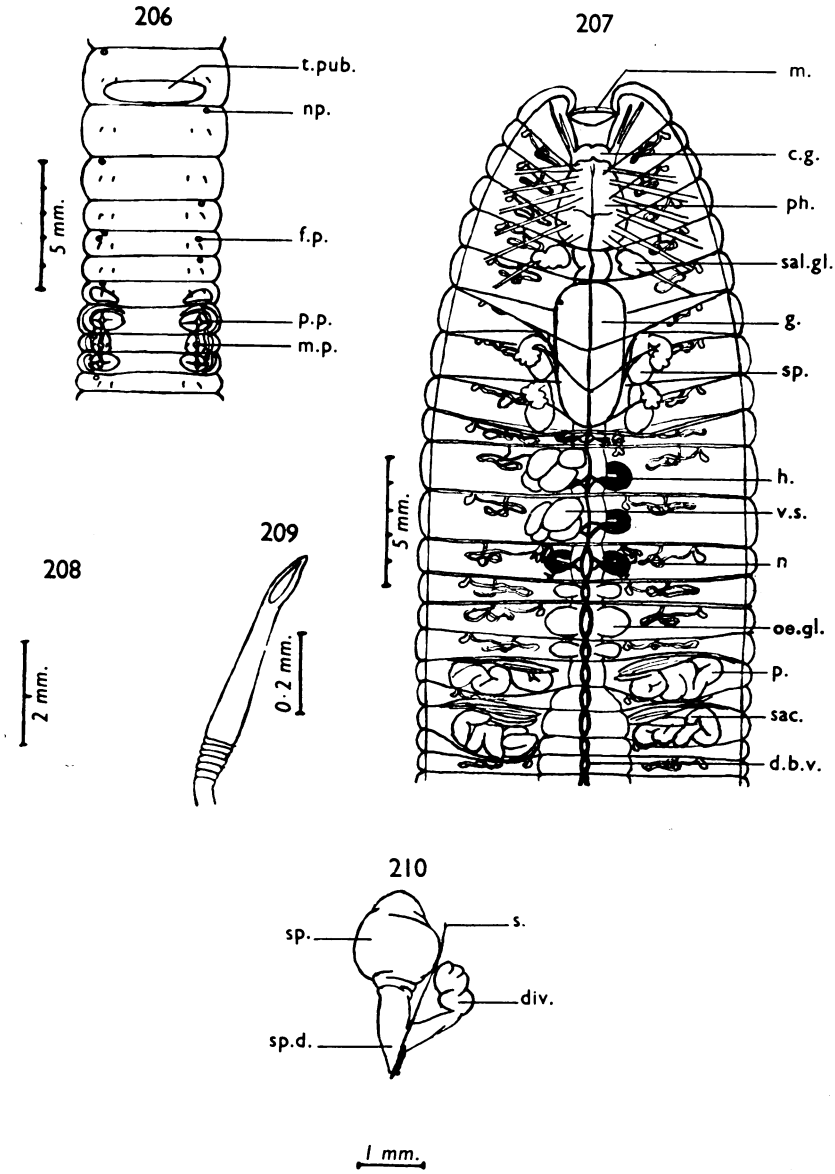

FIGS. 206–210. *Maoridrilus nelsoni* n.sp.
206. Ventral aspect, segments x–xx
207. Dissection from dorsal aspect, segments i–xxi
208. Penial chaeta
209. Tip of penial chaeta
210. Right anterior spermatheca, postero-lateral aspect

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Dorsal blood vessel paired posterior to xii/xiii, but the two vessels fuse at each septum. Unpaired supra-intestinal vessel present. Hearts in x, xi, xii, xiii, connected to dorsal and supra-intestinal blood vessels.

Testes in x, xi, small, compact. Ovaries in xiii, consisting of a number of filiform processes. Vesiculae seminales in xi, xii, lobed sac-like organs. Prostates in xvii, xix, convoluted, tubular. Penial chaetae in xvii, xix; slender sigmoid shaft with slightly swollen spoon-shaped tip set off rather sharply from shaft; transverse striations adjacent to angle between tip and shaft (Figs. 208, 209). Spermathecae in viii, ix; irregular ovoidal sac with long, wide, muscular duct; small, irregular, ovoidal diverticulum in next anterior segment, set at sharp angle to slender diverticular duct, which passes through septum to open into spermathecal duct. (Fig. 210).

Nephridial vesicles present.

Type Locality: Whangamoa Saddle, N.E. of Nelson; topsoil and litter, beech forest; K.E.L., 26/5/54.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 7 specimens. Lee River Valley, Nelson; topsoil, manuka scrub; K.E.L., 26/5/54; 1 specimen. Takaka Hill, Motueka; topsoil, beech forest; K.E.L., 28/5/54; 3 specimens.

Maoridrilus pallidus n.sp. Figs. 211–213

Length 74 mm. Diameter 3·5 mm. 186 segments.

Colour pink and irridescent, with buff clitellum.

Clitellum xiv–xx, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment, very closely paired: ab=cd; bc>dd>aa≫ab.

Prostatic pores on small, rounded papillae, on xvii, xix, in line with chaetal interval ab.

Male pores on xviii, in seminal grooves, between chaetae a and b.

Female pores on xiv, anterior and slightly lateral to chaeta b.

Spermathecal pores on xiv, anterior and slightly lateral to chaeta b. Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores of ii in line with chaeta d, of iii–xi with c, of xii with b, and thereafter alternately in line with c and b.

Septa ix/x to xii/xiii thickened.

Pharynx in i–v, large, globular. Proventriculus in vi, short, thin walled. Gizzard in vii. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae absent. Spermathecae in viii, ix; elongate ovoidal sac with short wide duct; irregular spheroidal diverticulum opens by short narrow duct into spermathecal duct. (Fig. 213).

Nephridial vesicles present.

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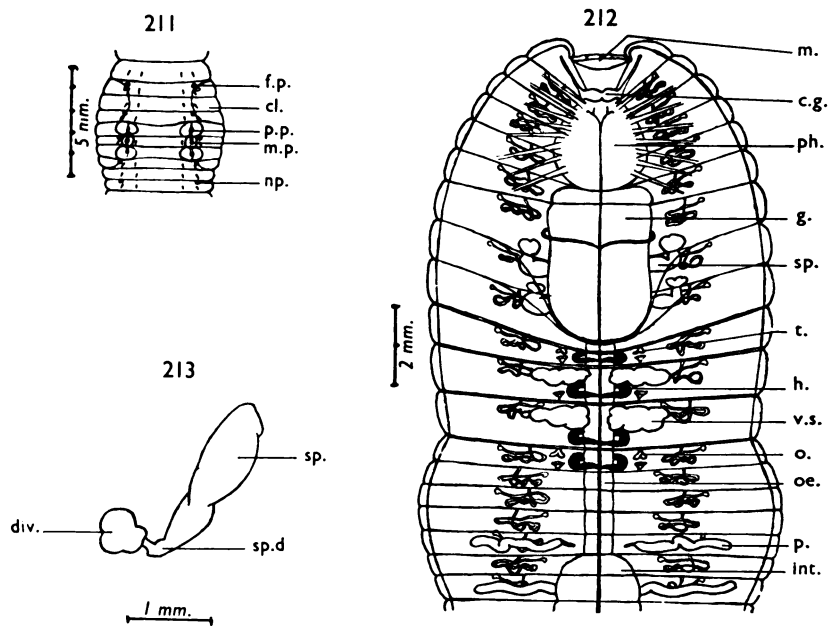

FIGS. 211–213. *Maoridrilus pallidus* n.sp.
211. Ventral aspect, segments xiii–xxii
212. Dissection from dorsal aspect, segments i–xix
213. Left posterior spermatheca, posterior aspect

Type Locality: Plateau Road, Upper Hutt; topsoil, podocarp-broad-leaved forest; K.E.L., 1/9/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. N.E. slope of Mt. Wainui, near Paekakariki; topsoil, pasture near forest edge; K.E.L., 18/11/53; 3 specimens. N.E. slope of Mt. Wainui; under stones, broadleaved forest; K.E.L., 18/11/53; 2 specimens.

Maoridrilus parkeri (Beddard)

1895 *Acanthodrilus parkeri* Beddard, Monograph p. 534.
1900 *Maoridrilus parkeri,* Michaelsen, Tierreich 10:124.
1905 *Maoridrilus Parkeri,* Ude, Z. wiss. Zool. 83.
1910 *Maoridrilus parkeri,* Michaelsen, Mitt. zool. Mus. Hamb. 27:70.
1937 *Maoridrilus parkeri,* Pickford, Monograph pp. 91, 603.

Length 184 mm. Diameter 9 mm. 185 segments.

Colour brown (preserved).

Clitellum xiii–xix, dorsal and lateral.

Prostomium prolobous.

Chaetae 8/segment; closely paired.

Prostatic pores on papillae, on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

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Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, 8/9.

Nephridiopores alternately dorso-lateral and ventro-lateral.

Septa vii/viii to xvi/xvii thickened.

Gizzard in vi–vii, strong. Oesophageal glands in xiv, xv, xvi, those of xiv smaller than those of xv, xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular and convoluted. Penial chaetae stout and sigmoid, no ornamentation, blunt. Spermathecae in viii, ix, with two mulberry-like diverticula.

Nephridial vesicles present.

Type Locality: New Zealand (no further details of type locality known); F. E. Beddard, 1895.

Type (?) specimen in British Museum (Nat. Hist.), collection registration No. 1904.10.

Localities:

South Island: Rakaia Gorge; ex leaf mould, forest; R. R. Forster, 30/4/50; 2 specimens.

Maoridrilus plumbeus (Beddard). Figs. 214, 215

1895 *Acanthodrilus plumbeus* Beddard, Monograph p. 548.
1900 *Maoridrilus plumbeus,* Michaelsen, Tierreich 10:123.
1905 *Maoridrilus plumbeus,* Ude, Z. wiss. Zool. 83.
1937 *Maoridrilus plumbeus,* Pickford, Monograph p. 91.

The description given by Beddard (1895) was very short and contained little detail. The following description is based on a specimen collected by the author from Te Akau, W. Waikato, close to Beddard's type locality, and identified by the author as *M. plumbeus.*

Length 27 mm. Diameter 2 mm. 98 segments.

Colour dark brownish grey when alive, leaden blue in alcohol.

Clitellum xii–xix, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=dd>cd.

Prostatic pores on small papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores of ii–x in line with chaeta c, of xi to chaeta b, posterior to xi alternating between c and b.

No specially thickened septa.

Proventriculus in v. Gizzard in vi. Oesophageal glands in xiv, xv. Intestine commences in xvii.

Dorsal blood vessel paired posterior to xii/xiii but the two vessels fuse at each septum. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

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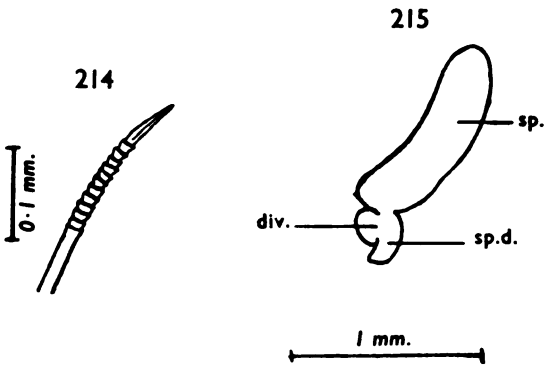

FIGS. 214, 215. *Maoridrilus plumbeus*
214. Tip of penial chaeta
215. Right posterior spermatheca, medial aspect

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, compact, sac-like. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; slender, gently curved shaft tapering abruptly to chisel-shaped point; small transverse ridges around shaft near tip (Fig. 214). Spermathecae in viii, ix; elongate tubular sac sharply set off from thick duct; small rounded diverticulum attached closely to anterior aspect of duct. (Fig. 215).

Nephridia with small tubular vesicles, those of the dorsal nephridia slightly longer than those of the ventral nephridia.

Type Locality: Mt. Pirongia, W. Waikato; F. E. Beddard, 1895.

Whereabouts of type specimen unknown.

Localities:

North Island: 7 miles from Te Akau, W. Waikato; leaf mould, forest; K.E.L., 20/5/50; 1 specimen.

Maoridrilus purus Ude

1905 *Maoridrilus purus* Ude, Z. wiss. Zool. 83.
1937 *Maoridrilus purus*, Pickford, Monograph p. 91.

Length 130–140 mm. Diameter 6–7 mm. 180 segments.

Colour dark brown with pale brown clitellum.

Clitellum (½xiii)xiv–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; dd>bc>aa>ab.

Prostatic pores on large papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores alternating between positions anterior to chaetae b and d, posterior to x.

Septa vi/vii to xv/xvi thickened.

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Gizzard in vi. Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel paired in i–vi; in vii–xvi or xvii the vessel is paired but the two vessels fuse at the intersegmental septa; posterior to xvi or xvii the vessel is unpaired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, coiled. Penial chaetae in xvii, xix; slightly sigmoid shaft without ornamentation, recurved slightly at tip and hollowed out in a truncated trowel-like shape. Spermathecae in viii, ix; sac long and ovoidal with short duct; small round diverticulum opens directly into spermathecal duct.

Nephridia with small vesicles.

Type Locality: Port Hills, Lyttelton; H. Ude, 1905.

The type specimen of this species has not been located.

Localities:

South Island: Lake Taylor (Hurunui R.), North Canterbury; under moss; Canterbury Museum Field Club, 14/4/52; 4 specimens. Porters Pass, 3,100 ft.; leaf mould and moss, mountain shrubs; K.E.L., 17/10/53; 5 specimens.

Maoridrilus ruber n.sp. Figs. 216–219

Length 121 mm. Diameter 7·5 mm. 207 segments.

Colour dark purplish red, irridescent dorsally, pale ventrally, with red clitellum.

Clitellum xiii–xx, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; dd>bc>aa>ab.

Posterior to the clitellum the body is almost square in cross section with the closely paired chaetae occupying the corners of the square on each segment.

Prostatic pores on small, rounded papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores of ii anterior to chaeta d, of iii–xii anterior to c, of xiii anterior to b, posterior to xiii alternately anterior to c and b.

Septa x/xi to xvi/xvii thickened.

Pharynx in i–iv, slender. Proventriculus in v–vi, thin walled. Gizzard in vii–viii. Oesophageal glands in xv, xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired anteriorly; posterior to iv it is paired but the two vessels fuse at each septum. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, small, bilobed organs. Ovaries in xiii; dorso-ventrally flattened laminar organs. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; long slender shaft, slightly sigmoid, terminating in sharp point (Fig.

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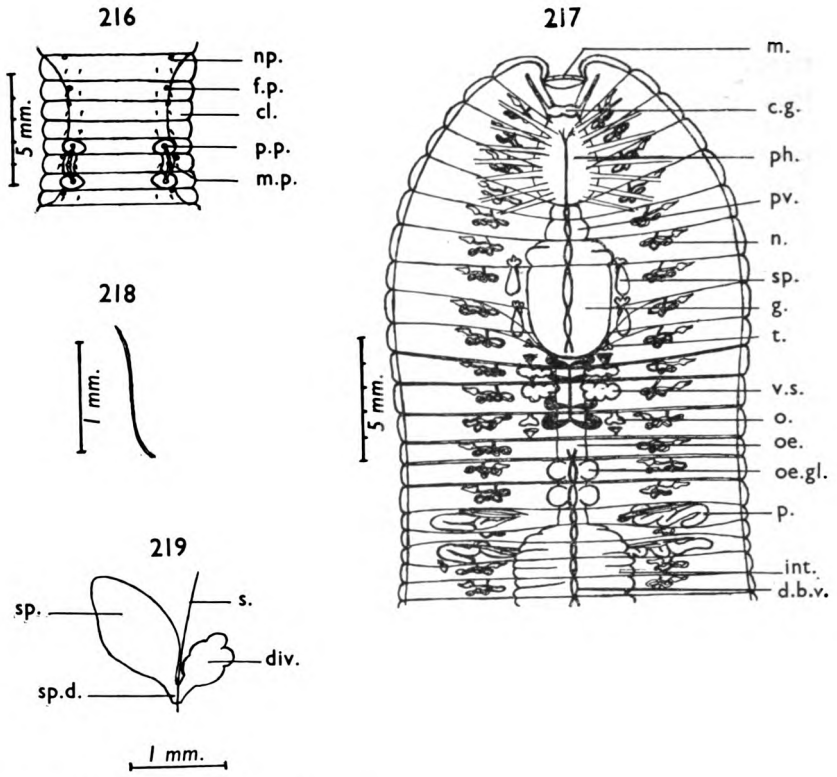

FIGS. 216–219. *Maoridrilus ruber* n.sp.
216. Ventral aspect, segments xiii–xx
217. Dissection from dorsal aspect, segments i–xx
218. Penial chaeta
219. Right posterior spermatheca, lateral aspect

218). Spermathecae in viii, ix; large ovoidal sac with narrow duct; small round diverticulum with pustulate surface lies in adjacent anterior segment and opens into spermathecal duct through short narrow duct passing through septum. (Fig. 219).

Nephridial vesicles present.

Type Locality: Taita, near Wellington; topsoil, beech forest; K.E.L., 26/4/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Taita Soil Expt. Station; topsoil, broadleaved forest; K.E.L., 16/9/54; 4 specimens. Taita Soil Expt. Station; topsoil and rotten logs; K.E.L., 5/54; 4 specimens. Whitemans Valley, near Upper Hutt; rotten log; A. C. S. Wright, 8/4/51; 2 specimens. Rimutaka Ra., near summit on Wairarapa side; topsoil, beech forest; K.E.L., 19/4/50; 1 specimen. N.E. slopes of Mt. Wainui, near Paekakariki; under stones, broadleaved forest; K.E.L., 18/11/53; 1 specimen. Mt. Wainui; topsoil under stones; K.E.L., 18/11/53; 1 specimen.

Kapiti Island: ¼ mile S. of Kapiti trig, 30 ft. from cliff edge; under stone, forest; K.E.L., 26/1/54; 1 specimen. N. side of Taepiro Valley; subsoil under

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boulder, coastal shrubs; K.E.L., 26/1/54; 1 specimen. Head of Taepiro Valley; topsoil, coastal shrubs and grass; K.E.L., 26/1/54; 10 specimens. E. side of island, very steep slope; topsoil, coastal scrub; K.E.L., 27/1/54; 1 specimen. E. coast of island, steep slope near N. end, 30 ft. above sea level; leaf mould and shingle, coastal forest; K.E.L., 27/1/54; 1 specimen. E. coast of island, steep slope 50 yd. S. of mouth of Te Mimi o Rokapa Stm.; topsoil, coastal forest; K.E.L., 28/1/54; 3 specimens.

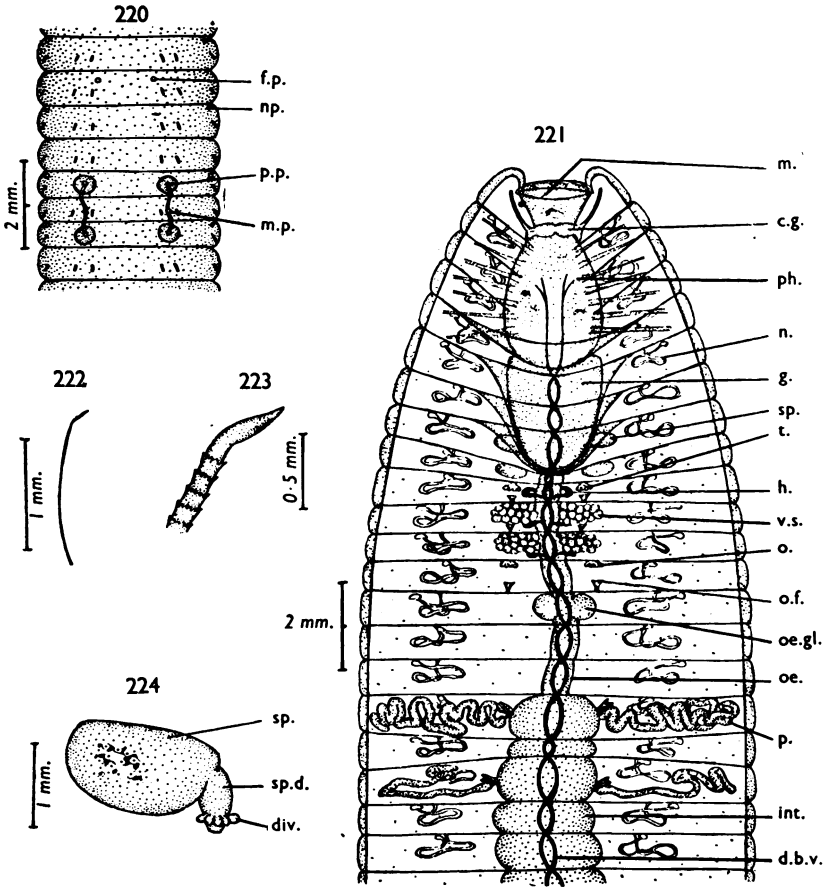
Mana Island: W. coast of island, steep slope; topsoil, scrub; M. L. Leamy, 29/9/54; 2 specimens.

Stephen Island; D. E. Hurley, 1950; 1 specimen.

Maoridrilus rubicundus n.sp. Figs. 220–224

Length 61 mm. Diameter 4·5 mm. 93 segments.

Colour brick red dorsally, paler ventrally, with slightly darker colouration in clitellar region.



FIGS. 220–224. *Maoridrilus rubicundus* n.sp.
220. Ventral aspect, segments xiii–xx
221. Dissection from dorsal aspect, segments i–xxi
222. Penial chaeta
223. Tip of penial chaeta
224. Right posterior spermatheca, anterior aspect

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Clitellum xiii–xx, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: cd≫ab; aa=bc; dd>cd>aa.

Prostatic pores on low rounded papillae on xvii, xix, in line with chaeta b.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Nephridiopores more or less alternately anterior to chaetae c and d, occasionally to chaeta b. (Usually in the genus the pores alternate from b to c or b to d.)

No specially thickened septa.

Pharynx in i–iv, covered by dense mass of salivary glands. Gizzard in v, long and strong walled. Oesophageal glands in xiv. Intestine commences in xvii.

Dorsal blood vessel paired, but the two vessels fuse at each septum. Hearts from dorsal blood vessels in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii, xix, tubular, convoluted, slender; those of xvii longer, wider and more coiled than those of xix. Penial chaetae in xvii, xix; long, slightly curved, slender shaft with small spiny ridges surrounding the distal quarter of its length; tip sharply curved and pointed (Figs. 222, 223). Spermathecae in viii, ix; large, flattened, oval sac with wide muscular duct; six very small rounded diverticula clustered around lateral and anterior aspects of spermathecal duct close to body wall. (Fig. 224).

Nephridial vesicles present.

Type Locality: Mokai Patea, Ruahine Ra., 5,000 ft.; soil in rock cleft; A. P. Druce, 2/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Mokai Patea, Ruahine Ra., 4,000 ft.; ground surface, tussock; A. C. S. Wright, 2/51; 1 specimen.

Maoridrilus smithi (Beddard). Figs. 225, 226

1892 *Acanthodrilus smithi* Beddard, Proc. zool. Soc. Lond., 1892, p. 675.
1894 *Acanthodrilus smithi,* Smith, Trans. N.Z. Inst. 26:171–3.
1895 *Acanthodrilus smithi,* Beddard, Monograph p. 535.
1895 *Acanthodrilus smithii,* Beddard, Proc. zool. Soc. Lond., 1895, p. 213.
1900 *Maoridrilus smithi,* Michaelsen, Tierreich 10:125.
1905 *Maoridrilus Smithi,* Ude, Z. wiss. Zool. 83.
1910 *Maoridrilus smithi,* Michaelsen, Mitt. zool. Mus. Hamb. 27:69.
1937 *Maoridrilus smithi,* Pickford, Monograph pp. 91, 603.

Length 75 mm. Diameter 3 mm. 114 segments, more or less square in cross section posterior to the clitellum. The segments are very clearly defined in the living worm.

Colour rich brown when alive, violet in alcohol.

Clitellum xiii–xix, dorsal and lateral.

Prostomium tanylobous.

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Chaetae 8/segment, closely paired with the pairs on the corners of the square segments, pairs equidistant.

Prostatic pores on papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, slightly antero-lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, slightly lateral to line of chaeta b.

Nephridiopores alternately anterior to chaetae b and c.

Gizzard in v, very small. Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae in xvii, xix; recurved at extreme end, tip flattened in oval shape and bifid (Fig. 225). Spermathecae in viii, ix; three small diverticula open into spermathecal duct; one diverticulum of each spermatheca projects forwards through the septum into the next anterior segment. (Fig. 226).

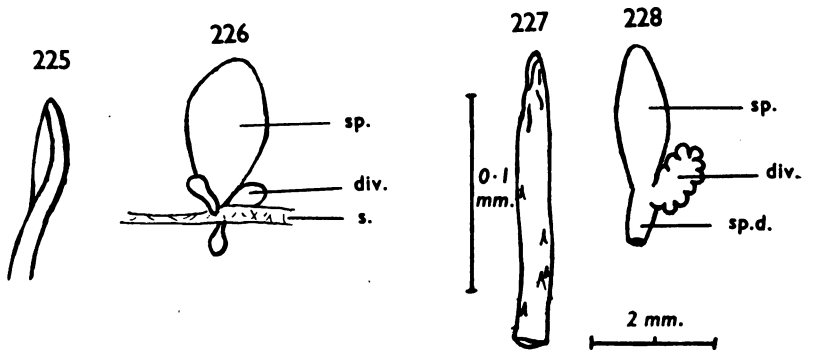
Nephridial vesicles present.

Type Locality: Albury, South Canterbury; in tussock land; F. E. Beddard, 1892.

Type (?) specimen in British Museum (Nat. Hist.), collection registration No. 1904.10.

Localities:

South Island: Kakahu; leaf mould; R. R. Forster, 30/4/50; 14 specimens.



FIGS. 225, 226, *Maoridrilus smithi*
225. Tip of penial chaeta
226. Spermatheca
(Drawings after Beddard, 1892b)

FIGS. 227, 228. *Maoridrilus suteri*
227. Tip of penial chaeta
228. Spermatheca
(Drawings after Michaelsen, 1922)

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Maoridrilus suteri Michaelsen. Figs. *227*, *228*

1922 *Maoridrilus suteri* Michaelsen, Capita zool. 1 (3) :16–7.
1937 *Maoridrilus suteri,* Pickford, Monograph p. 91.

This species has not been re-collected since the original description was written by Michaelsen (1922). The following description is taken from Michaelsen:

Length 140 mm. Diameter 7 mm. c.160 segments.

Colour pale smoky grey dorsally in anterior region, otherwise yellowish grey (in alcohol).

Clitellum xiv–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc=dd>ab.

Prostatic pores on faint circular papillae on xvii, xix, in line with chaetal interval ab.

Male pores in shallow seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores alternately anterior to pairs of chaetae ab and cd.

Septa vi/vii to xiv/xv thickened.

Gizzard in vi, large and strong. Oesophageal glands in xiv; oesophagus wider than normal in xii, xiii. Limits of oesophagus and intestine not mentioned.

Dorsal blood vessel paired in x–xiv, but the two vessels fuse at each septum; unpaired posterior to xiv/xv. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii, xix, tubular, convoluted, compressed. Penial chaetae with long, slender, gently curved shaft terminating in a blunt conical tip; small spines ornament shaft near distal end (Fig. *227*). Spermathecae in viii, ix; elongate ovoidal sac, terminating bluntly, opening by a somewhat narrower duct about half as long as the sac; small rounded diverticulum with surface upraised in reniform pustules opens by a very short wide duct into the anterior aspect of the organ at the junction of the sac and the duct. (Fig. *228*).

Nephridial vesicles not described.

Type Locality: Christchurch; W. Michaelsen, 1922.

Type specimen in collections of Museum of Natural History, Leyden, Holland.

Localities: None.

Maoridrilus tetragonurus Michaelsen

1899 *Maoridrilus tetragonurus* Michaelsen, Zool. Jahrb. Syst. 12:230.
1900 *Maoridrilus tetragonurus,* Michaelsen, Tierreich, 10:124–5.
1905 *Maoridrilus tetragonurus,* Ude, Z. wiss. Zool. 83.
1919 *Maoridrilus tetragonurus,* Benham, Trans. N.Z. Inst. 51:34.
1937 *Maoridrilus tetragonurus,* Pickford, Monograph p. 91.

Length 160–280 mm. Diameter 8–10 mm. c.200 segments.

Colour greyish violet dorsally, paler ventrally and posteriorly.

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Clitellum xii–xx, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=bc=dd≫ab. Posterior to clitellum body is more or less square in cross section with closely paired chaetae at corners of square.

Prostatic pores on low rounded papillae, on xvii, xix, in line with chaeta a.

Male pores in seminal grooves on xviii; seminal grooves curve medially as they pass across xviii.

Female pores on xiv, anterior to chaetal interval ab.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores of .ii–x in line with chaetal interval cd, posterior to x alternating between positions in line with chaeta b and interval cd.

Septa vii/viii to xvi/xvii thickened.

Gizzard in vii. Oesophageal glands in xiv, xv, xvi, xvii. Intestine commences in xx.

Dorsal blood vessel paired but the two vessels fuse at each septum.

Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii; those of ix, x small and sac-like, those of xi, xii large and racemose. Prostates in xvii, xix, tubular, tightly coiled. Penial chaetae with gently curved shaft, sharply bent distally, terminating in a grooved tip armed with transverse rows of small teeth. Spermathecae in viii, ix; large pyriform sac with short duct; large spheroidal diverticulum with short thick duct opens into anterior aspect of spermathecal duct.

Type Locality: Stephen Island; W. Michaelsen, 1899.

Type specimen in Zoological Museum, Hamburg.

Previous Records:

Stephen Island; W. B. Benham, 1919.

Maoridrilus transalpinus n.sp. Figs. *229–232*

Length 163 mm. Diameter 5·5 mm. 231 segments.

Colour light brown with no noticeable clitellum.

Prostomium tanylobous.

Chaetae 8/segment: ab>cd; dd=bc>aa≫ab.

Prostatic pores on small papillae on xvii, xix, in line with chaetal interval ab.

Male pores in seminal grooves on xviii, in line with prostatic pores.

Female pores on xiv, anterior and slightly medial to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores of ii–ix anterior to chaeta c; those of x–xi anterior to chaeta b; posterior to xi alternating more or less regularly between c and b.

Septa ix/x to xii/xiii thickened.

Pharynx in i–iv, covered dorsally and laterally by masses of salivary glands. Proventriculus in v, short, narrow, thin walled. Gizzard in vi,

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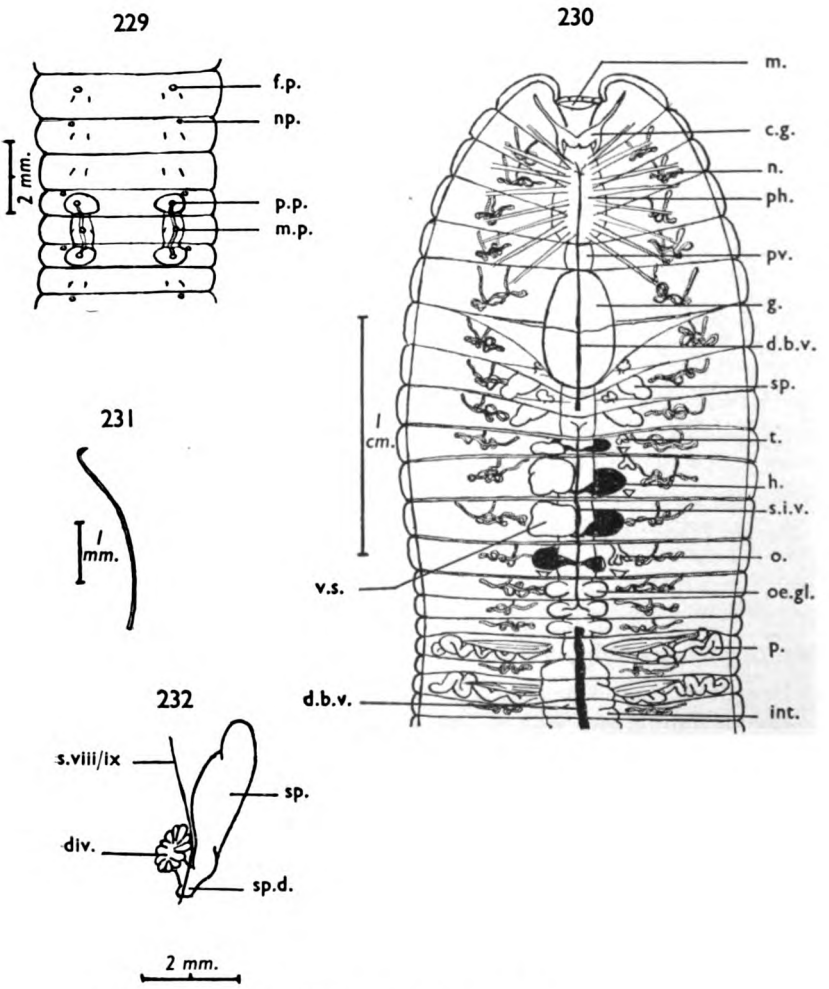
long, thick walled. Oesophageal glands in xiv, xv, xvi. Intestine commences in xviii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii, sac-like. Prostates in xvii, xix, long, tubular, convoluted. Penial chaetae in xvii, xix; gently curved, stout shaft, with recurved, flattened, blunt tip (Fig. 231). Spermathecae in viii, ix; long tubular sac with short thick duct; small diverticulum, antero-posteriorly flattened, with ridged surface, lies in next anterior segment and opens into spermathecal duct by a short duct passing through the septum. (Fig. 232).



FIGS. 229–232. *Maoridrilus transalpinus* n.sp.
229. Ventral aspect, segments xiv–xx
230. Dissection from dorsal aspect, segments i–xx
231. Penial chaeta
232. Right posterior spermatheca, medial aspect

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Nephridial tubules large, without vesicles.

Type Locality: Lake Mahinapua Forest Reserve, Westland; leaf mould, podocarp-broadleaved forest; K.E.L., 14/1/53.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 2 specimens. Lake Mahinapua Forest Reserve, Westland; topsoil, podocarp-broadleaved forest; K.E.L., 16/1/53; 2 specimens. Lake Manapouri; ex moss; R. R. Forster, 23/1/51; 1 specimen.

Maoridrilus uliginosus (Hutton). Figs. 233, 234

1877 *Lumbricus uliginosus* Hutton, Trans. N.Z. Inst. 9:351.
1883 *Acanthodrilus uliginosus,* Hutton, N.Z. J. Sci. 1:585.
1885 *Acanthodrilus uliginosus* + *Acanthodrilus novae zelandiae,* Beddard, Proc. zool. Soc. Lond., 1885, pp. 812–3.
1886 *Acanthodrilus novae zealandiae,* Beddard, Proc. zool. Soc., Lond., 1886, p. 169.
1889 *Acanthodrilus novae-zealandiae,* Beddard, Quart. J. micr. Sci. 29:102.
1889 *Acanthodrilus novae-zealandiae,* Beddard, Quart. J. micr. Sci. 29:242.
1889 *Acanthodrilus novae-zealandiae* + *Acanthodrilus rosae,* Beddard, Proc. zool. Soc. Lond., 1889, pp. 378–9.
1890 *Acanthodrilus novae-zealandiae,* Beddard, Quart. J. micr. Sci. 30:428.
1890 *Acanthodrilus rosae,* Beddard, Quart. J. micr. Sci. 30:434–41.
1890 *Acanthodrilus novae-zealandiae* + *Acanthodrilus rosae,* Benham, Quart. J. micr. Sci. 31:230.
1891 *Acanthodrilus novae Zelandiae* + *Acanthodrilus uliginosus* + *Acanthodrilus Rosae,* Beddard, Proc. R. phys. Soc., Edinb. 10:278.
1892 *Acanthodrilus novae-zelandiae,* Beddard, Proc. zool. Soc. Lond., 1892, p. 669.
1893 *Acanthodrilus novae-zealandiae,* Smith, Trans. N.Z. Inst. 25:115.
1893 *Acanthodrilus rosae,* Smith, Trans. N.Z. Inst. 25:125–7.
1894 *Acanthodrilus novae-zealandiae* + *Acanthodrilus rosae,* Smith, Trans. N.Z. Inst. 26:156.
1895 *Acanthodrilus novae-zealandiae* + *Acanthodrilus rosae,* Beddard, Monograph p. 534.
1899 *Acanthodrilus uliginosus,* Benham, Ann. Mag. nat. Hist., ser. 7, 3:137.
1899 *Maoridrilus uliginosus,* Michaelsen, Zool. Jahrb. Syst. 12:234.
1900 *Lumbricus uliginosus* sp. dub., Michaelsen, Tierreich 10:419.
1900 *Maoridrilus novaezelandiae* + *Maoridrilus rosae,* Michaelsen, Tierreich 10:123–4.
1901 *Acanthodrilus* (*Maoridrilus*) *uliginosus* + *Acanthodrilus rosae,* Benham, Trans. N.Z. Inst. 33:122–8.
1905 *Maoridrilus novae-zealandiae* + *Maoridrilus uliginosus* + *Maoridrilus rosae,* Ude, Z. wiss. Zool. 83.
1913 *Maoridrilus uliginosus* + *Maoridrilus rosae,* Cameron, Trans. N.Z. Inst. 45:172–90.
1937 *Maoridrilus uliginosus* + *Maoridrilus rosae,* Pickford, Monograph p. 91.

Length 200–225 mm. Diameter 9 mm. 130–230 segments.

Colour reddish brown, fading slightly posteriorly, with a paler and browner clitellum.

Clitellum xiv–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment, closely paired, body almost square in cross section with the pairs of chaetae on the corners of the square in each segment: aa=bc=dd⩾ab.

Prostatic pores on small circular papillae, on xvii, xix, in line with chaeta a.

Male pores in seminal grooves on xviii, between chaetae a and b.

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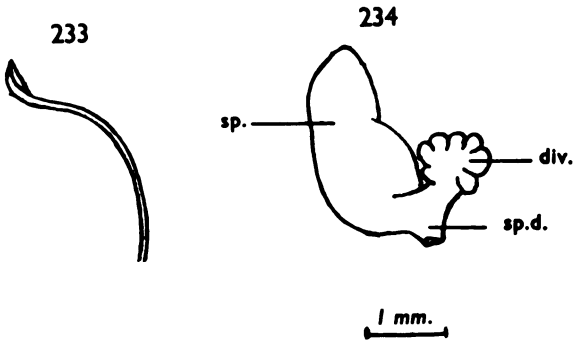

FIGS. 233, 234. *Maoridrilus uliginosus*
233. Tip of penial chaeta
234. Right spermatheca of viii, lateral aspect
(Drawings after Benham, 1901a)

Female pores on xiv, in line with chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores alternating more or less regularly between chaetal lines b and c posterior to x or xi.

Septa viii/ix to xii/xiii thickened.

Gizzard in vi. Oesophageal glands in xiv, xv, xvi. Intestine commences in xviii.

Dorsal blood vessel paired, but the two vessels fuse at each septum. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, large, tubular, coiled. Penial chaetae in xvii, xix; long, slender, gently curved, with spoon-shaped tip (Fig. 233). Spermathecae in viii, ix; large ovoidal sac with long wide duct; small blackberry-shaped diverticulum, usually in next anterior segment, opens into anterior aspect of spermathecal duct. (Fig. 234).

Nephridial vesicles present; those of the dorso-lateral series of nephridia differ from those of the ventro-lateral series.

Type Locality: Caversham (suburb of Dunedin); collected from a swamp where the town of Caversham now stands; F. W. Hutton, 1877.

Type specimen in Otago Museum (No. A.56.19). 1 specimen, in good condition.

Localities:

South Island: Mt. Furness, 2,000 ft., Marlborough Sounds; C. McCann, 6/12/53; 1 specimen. Lake Janet; under logs; R. R. Forster, 31/7/49; 2 specimens. Lindis Pass, Otago, 4,100 ft.; subsoil, snow tussock; K.E.L., 11/10/53; 5 specimens. Waipori Gorge; leaf mould and topsoil; K. Paviour-Smith, 15/7/54; 3 specimens. Flagstaff, near Dunedin; topsoil, tussock; K. Paviour-Smith, 25/4/54; 1 specimen.

Previous Records:

This species was recorded a number of times by Hutton, Smith, Beddard and Benham from eastern districts of the South Island, mainly under tussock grassland vegetation.

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Remarks: Beddard (1889c) described a species, *Acanthodrilus rosae* (=*Maoridrilus rosae*) closely similar to *M. uliginosus*. Benham (1901) distinguished the two species on the ground that *M. rosae* has a very short thick duct connecting the spermathecal diverticulum to the spermathecal duct, while *M. uliginosus* has no duct. This is not a satisfactory distinction, since *M. uliginosus* usually has the spermathecal diverticulum in the adjacent anterior segment, and there is a very short thick duct, passing through the septum to the spermathecal duct. The only other features that might be used to distinguish the two species are the thickening of the septa and very slight differences in the form of the nephridial vesicles. Neither of these two points is of sufficient importance to justify the retention of the two species.

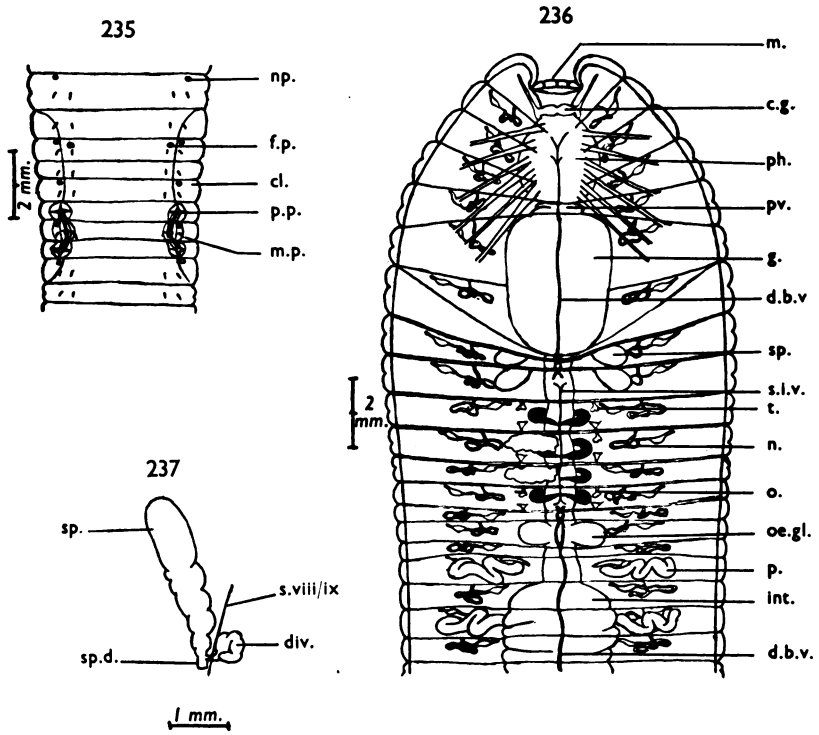
Maoridrilus ultimus n.sp. Figs. 235–237

Length 91 mm. Diameter 5 mm. 210 segments.

Colour pink with brownish clitellum (alive); pale brown with darker brown clitellum (in alcohol).

Clitellum xiii–xx, dorsal and lateral.

Prostomium tanylobous.



FIGS. 235–237. *Maoridrilus ultimus* n.sp.
235. Ventral aspect, segments xii–xxi
236. Dissection from dorsal aspect, segments i–xx
237. Right posterior spermatheca, lateral aspect

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Chaetae 8/segment; the body is more or less square in cross section with the pairs of chaetae on the corners of the square in each segment: ab=cd; dd=bc>aa≫ab.

Prostatic pores in grooves bordered by low tumid ridges on xvii, xix, in line with chaeta b.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior and slightly lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores posterior to ix alternating more or less regularly between positions anterior to chaetae b and c.

Septa vii/viii to xiv/xv thickened.

Pharynx in i–iv. Proventriculus in v, short, thin walled. Gizzard in vi, large, thick walled. Oesophageal glands in xv. Intestine commences in xviii.

Dorsal blood vessel unpaired anterior to vi/vii; from vi/vii to xv/xvi it is paired within the segments but the two vessels fuse at the septa; posterior to xv/xvi the vessel is unpaired. Unpaired supra-intestinal vessel commences in ix. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; long tubular sac tapering to wide duct; narrow tubular diverticulum originating from proximal end of duct and passing through septum into next anterior segment, where it curves in a spiral. (Fig. 237).

Nephridia with vesicles.

Type Locality: Steep hillside E. of Wash Bridge, Wairau Valley; topsoil, *Festuca* tussock; K.E.L., 31/5/54.

Type specimen in Soil Bureau collection.

Localities:

South Island: Same data as type material; 17 specimens. 9 miles S. of Picton; topsoil, manuka scrub; K.E.L., 1/6/54; 2 specimens.

Maoridrilus volutus n.sp. Figs. 238–241

Length 108 mm. Diameter 4·75 mm. 238 segments.

Colour light brown with buff clitellum.

Clitellum ½xiii–½xx, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment; posterior end of body (about 80 segments) more or less square in cross section with the pairs of chaetae on the corners of the square on each segment: ab=cd; bc>dd>aa≫ab.

Prostatic pores on small papillae on xvii, xix, in line with chaeta a.

Male pores in seminal grooves on xviii, medial to chaeta a.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores close to anterior margins of viii, ix, in line with chaeta a.

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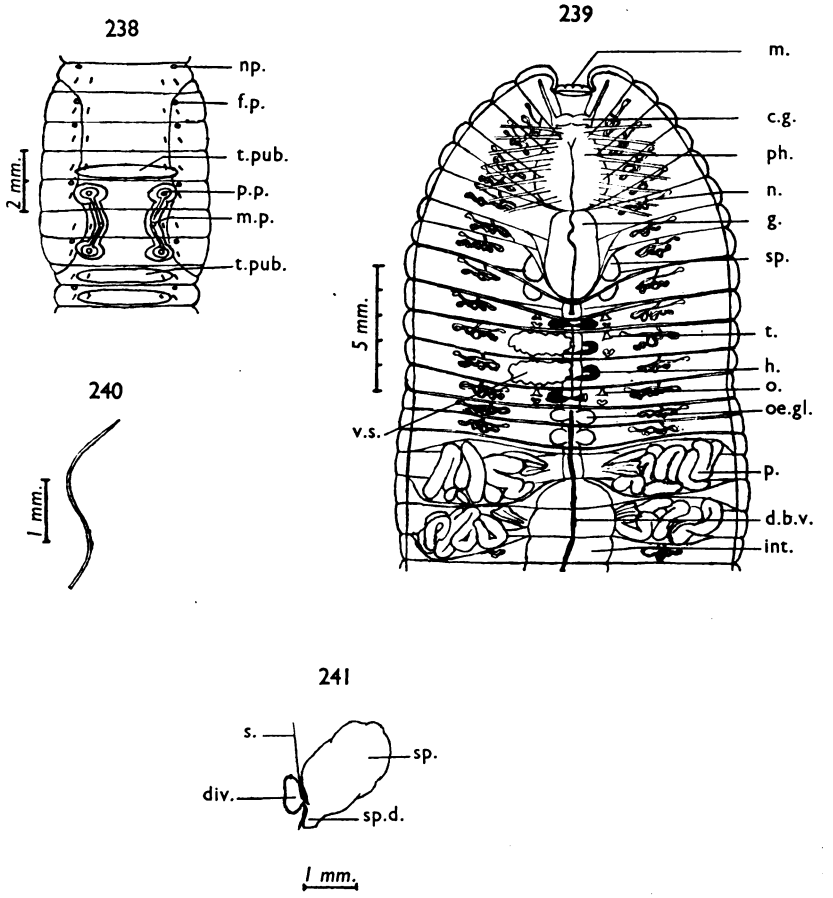
Nephridiopores alternately anterior to chaetae b and c posterior to x. Three long narrow tubercula pubertatis extending across ventral surfaces of xvi, xx, xxi, from chaeta b to chaeta b.

Septa viii/ix to xiv/xv thickened.

Pharynx in i–iv. Proventriculus in v, short, thin walled. Gizzard in vi. Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, xix, very long, tubular, coiled and convoluted. Penial chaetae in xvii, xix; long, slender shaft, twisted in corkscrew fashion, with one complete turn in its length, terminating in sharp point (Fig. 240). Spermathecae in viii, ix; large cuboidal sac opening by wide duct; small ovoidal diverticulum in next anterior segment opens



FIGS. 238–241. *Maoridrilus volutus* n.sp.
238. Ventral aspect, segments xiii–xxi
239. Dissection from dorsal aspect, segments i–xx
240. Penial chaeta
241. Right posterior spermatheca, medial aspect

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into spermathecal duct through narrow duct passing through septum. (Fig. 241).

Nephridia large, with small vesicles.

Type Locality: Te Mimi o Rakopa Stm., Kapiti Island; topsoil, coastal forest; K.E.L., 28/1/54.

Type specimen in Soil Bureau collection.

Localities:

Kapiti Island: Same data as type material; 1 specimen. E. side of island, ¼ mile N. of Rangatira Point; topsoil, scrub; K.E.L., 27/1/54; 1 specimen. Track to Kapiti trig, ¼ mile S. of caretaker's house; topsoil, coastal forest; K.E.L., 28/1/54; 5 specimens. Head of Taepiro Valley; topsoil, coastal scrub and grasses; K.E.L., 26/1/54; 2 specimens.

Maoridrilus wilkini n.sp. Figs. 242–245

Length 110 mm. Diameter 4 mm. 179 segments.

Colour brick red dorsally, pale ventrally, with buff clitellum.

Clitellum xiv–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment, closely paired; posterior to clitellum body more or less square in cross section with pairs of chaetae on corners: ab=cd; dd=bc>aa≫ab.

Prostatic pores on xvii, xix, in line with chaetal interval ab, not on papillae.

Male pores in seminal grooves on xviii, between chaetae a and b.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores on extreme anterior margins of viii, ix, anterior and slightly lateral to chaeta a.

Nephridiopores alternately anterior to chaetae b and c posterior to ix.

Septa ix/x to xii/xiii thickened.

Pharynx in i–v. Gizzard in vi, very large and muscular. Oesophageal glands in xiii, xiv, xv, xvi; those of xiii and xvi smaller than those of xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Testes and ovaries made up of a number of pyriform lobes. Vesiculae seminales in ix, xi, xii, compact, sac-like; those of xi and xii divided into a number of lobes. Prostates in xvii, xix, long, slender, tubular, convoluted. Penial chaetae in xvii, xix; short stout shaft, gently curved distally and terminating in a round ball-like tip (Fig. 244). Spermathecae in viii, ix; small conical sac opening by long wide duct; small club-shaped diverticulum in next anterior segment opening by narrow duct through septum into spermathecal duct. (Fig. 245).

Nephridia with vesicles.

Type Locality: Wilkin River Valley, W. of Lake Wanaka, N.W. Otago; topsoil, grassy flat under *Nothofagus*; P. J. Harrigan, 12/52.

Type specimen in Soil Bureau collection.

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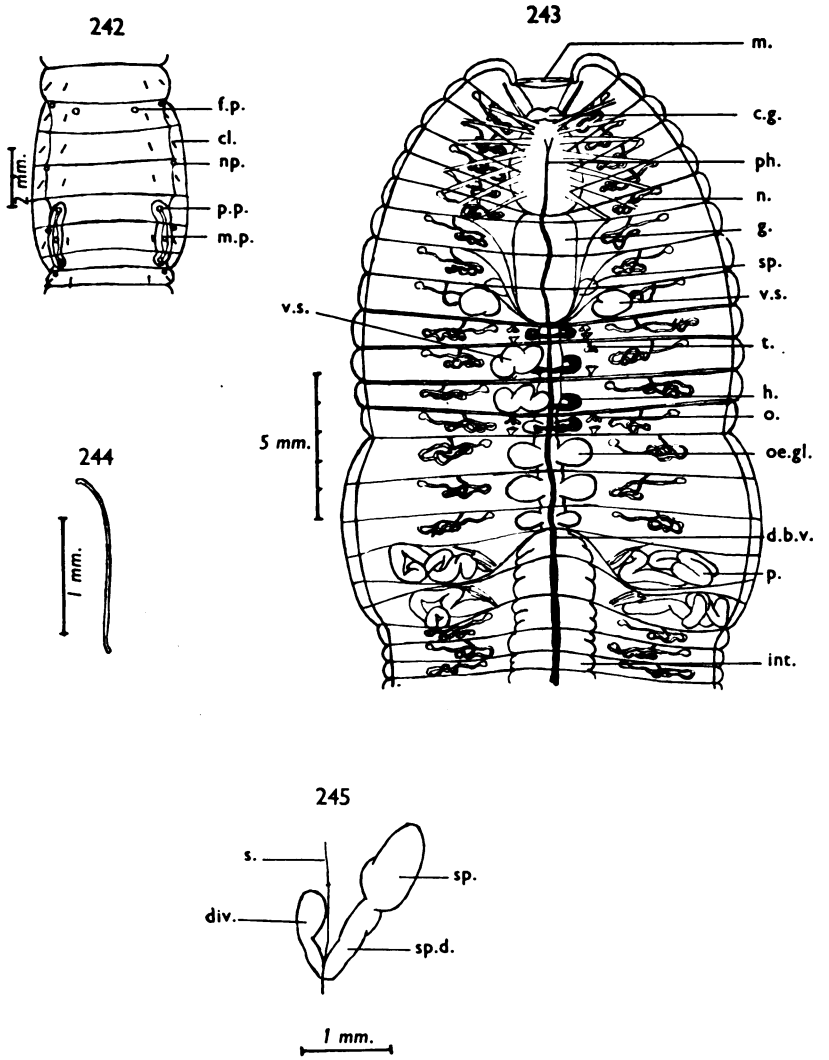

FIGS. 242–245. *Maoridrilus wilkini* n.sp.
242. Ventral aspect, segments xiii–xx
243. Dissection from dorsal aspect, segments i–xxii
244. Penial chaeta
245. Right anterior spermatheca, medial aspect

Localities:

South Island: Same data as type material; 1 specimen. Lake Diana, Wilkin Valley; under moss; P. J. Harrigan, 12/52; 1 specimen. Temple R., Lake Ohau; leaf mould; R. R. Forster, 1/50; 1 specimen. Mead's Landing, L. Hawea; leaf mould; R. R. Forster, 20/1/51; 2 specimens.

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Genus Neochaeta n.g.

Small, active, darkly pigmented worms. Chaetae numerous (more than 12) per segment. Clitellum on xiii–xviii (or ½xviii), complete for most of its length. Prostatic pores one pair, on xvii, not always on papillae. Male pores on extreme anterior margin of xviii. Female pores on xiv, paired, ventro-lateral. Spermathecal pores one pair, at 8/9. Nephridiopores alternately dorso-lateral and ventro-lateral except on the first few segments. Gizzard lacking; oesophageal glands lacking. Dorsal blood vessel unpaired; two pairs of hearts, the last in xii. Testes two pairs, in x, xi, not in testis sacs. Vesiculae seminales two pairs, in xi, xii. Prostates one pair, in xvii. Penial chaetae present. Spermathecae one pair, in ix; each spermatheca has one small diverticulum. Nephridial vesicles present.

Type species: *Neochaeta forsteri* n.sp.

Number of Species: Two.

Distribution: New Zealand; confined to southern North Island and northern South Island districts. (Fig. 363).

This genus includes two species of small, darkly pigmented, active worms, which inhabit leaf mould in forested areas. It differs from other genera of Neodrilacea in having the perichaetine arrangement of the chaetae, in combination with one pair of prostates, in xvii. *Plagiochaeta* has perichaetine chaetae but has two pairs of prostates, while *Neodrilus* has one pair of prostates, but has only eight chaetae on each segment.

Key to the Species of Neochaeta

a₁ Prostomium epilobous; prostatic papillae lacking; spermatheca with small, pyriform diverticulum in next anterior segment ..... **N. forsteri**

a₂ Prostomium tanylobous; prostatic papillae present; spermatheca with small, tubular, posterior diverticulum in same segment as spermathecal sac ..... **N. salmoni**

The two species are so similar as to be almost indistinguishable (Table 11). Only one specimen of *N. salmoni* has been collected, from Waiouru, while *N. forsteri* is fairly widely distributed in the south-east of the North Island and the north-east of the South Island. The reason for this disjunct distribution of the genus is not known. It is unlikely that the genus is common between Waiouru and the south-east of the North Island, as quite extensive collections have been made in this area, without producing further records of the genus.

Neochaeta forsteri n.sp. Figs. 246–249

Length 22 mm. Diameter 2·5 mm. 65 segments.

Colour brown, darker anteriorly than posteriorly, with a row of yellowish spots encircling each segment; a pair of very small chaetae arises from each spot.

Clitellum xiii–xviii, complete except for a small median ventral area on xvii–xviii where prostatic pores and male pores are situated.

Prostomium epilobous.

Chaetae 36/segment, very closely paired, pairs evenly spaced except for dorsal and ventral gaps.

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TABLE 11. Neochaeta

——	*forsteri*	*salmoni*
Length	22 mm.	15 mm.
Diameter	2·5 mm.	2 mm.
Segments	65	61
Colour	brown; yellow spot around each pair of chaetae	dark brown
Clitellum	xiii–xviii	xiii–½xviii
Extent of clitellum	complete except for small median ventral area on xvii–xviii	complete except for small median ventral area on xvii–xviii
Prostomium	epilobous	tanylobous
Chaetae/segment	18 pairs	18 pairs
Prostatic papillae	absent	small, round
Position of prostatic pores ..	anterior to ab	anterior to ab
Position of male pores ..	anterior margin of xviii in seminal grooves	anterior margin of xviii not in seminal grooves
Position of female pores ..	anterior to a/b	anterior to a/b
Position of spermathecal pores	8/9 a/b	8/9 a/b
Position of nephridiopores ..	ventro-lateral and dorso-lateral	ventro-lateral and dorso-lateral
1st ventral nephridiopore ..	vi	vii
Septal thickening	absent	absent
Proventriculus	absent	absent
Gizzard	absent	absent
Oesophageal glands	absent	absent
1st intestinal segment ..	xv	xvii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	2	2
Last heart	xii	xii
Origin of hearts	dorsal blood vessel	dorsal blood vesse
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	xi, xii racemose
Prostates	xvii	xvii
Penial chaetae	present	present
Copulatory muscles	absent	absent
Spermathecal diverticula:		
Number	1	1
Form	small, pyriform	small, tubular
Position	anterior, in next anterior segment	posterior
Nephridial vesicles	present	present

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Prostatic pores on xvii, transverse slit-like pores in position of ventral-most pairs of chaetae.

Male pores at anterior margin of xviii, at posterior end of seminal grooves, slightly lateral to line of ventral-most pair of chaetae.

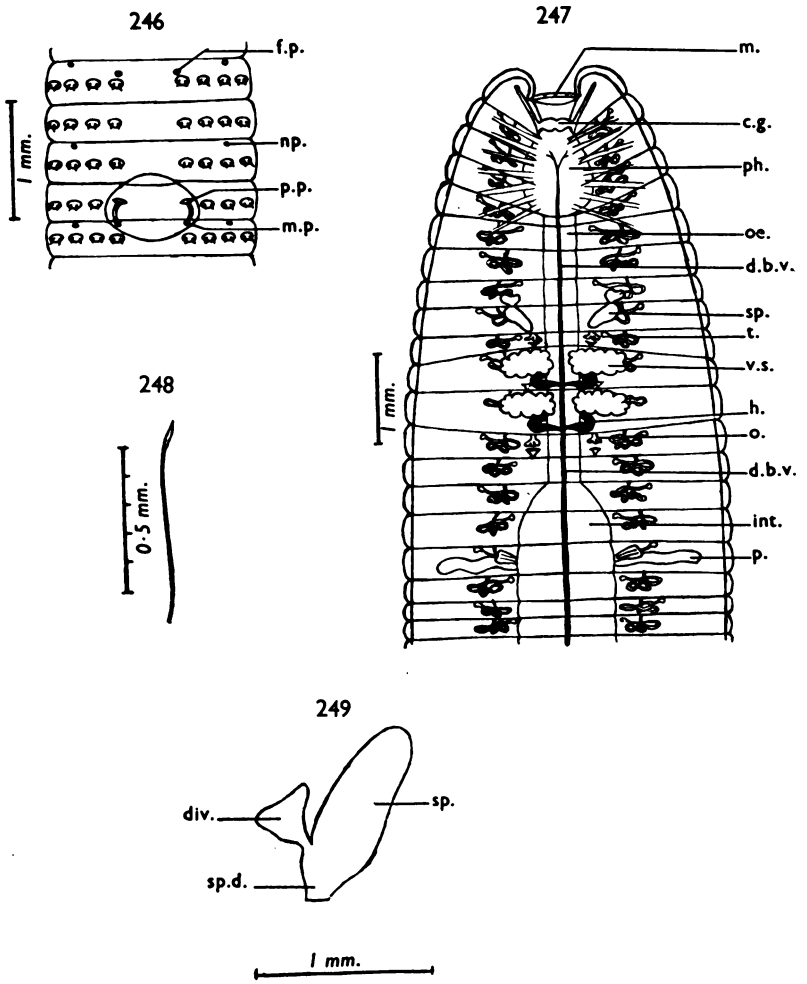
Female pores on xiv, anterior to ventral-most pair of chaetae.

Spermathecal pores at 8/9, very small, in line with ventral-most chaetae.

Nephridiopores alternately dorso-lateral and ventro-lateral posterior to v.

No specially thickened septa.

Pharynx in i–iv. Gizzard absent. Oesophageal glands absent. Intestine commences in xv.



FIGS. 246–249. *Neochaeta forsteri* n.sp.
246. Ventral aspect, segments xiv–xviii
247. Dissection from dorsal aspect, segments i–xx
248. Penial chaeta
249. Right spermatheca, medial aspect

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Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in xi, xii, those of xii larger than those of xi.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, tubular, not coiled. Penial chaetae in xvii; long slender spine, almost straight, slightly swollen near tip and sharply pointed (Fig. 248). Spermathecae in ix; small cylindrical sac with short wide duct not sharply differentiated from sac; small pyriform diverticulum in next anterior segment opens by short narrow duct through septum into anterior aspect of spermathecal duct. (Fig. 249).

Nephridia with small vesicles.

Type Locality: Mt. Ross, S. Wairarapa; ex moss; R. R. Forster, 5/4/47.

Type specimen in Dominion Museum collection.

Localities:

North Island: Same data as type material; 7 specimens.

South Island: Lake Taylor (Hurunui R.); moss; Canterbury Mus. Field Club, 14/4/52; 4 specimens. Lewis Pass; ex leaf mould; G. Southgate, 29/5/49; 11 specimens. Kiwi Valley; under moss; R. R. Forster, 14/11/49; 1 specimen. Kiwi Valley; leaf mould; R. R. Forster, 14/11/49; 1 specimen. Lake Rubicon; under moss; R. R. Forster, 19/11/50; 3 specimens. Hickory Bay, Akaroa; leaf mould; R. Pilgrim, 26/1/52; 7 specimens. Lake Janet, Mt. Gray; leaf mould; J. G. Dugdale, 25/8/51; 1 specimen. Mt. Grey; under moss; R. R. Forster, 27/3/51; 7 specimens. Chalk Hill, Canterbury; leaf mould; R. R. Forster, 4/11/51; 8 specimens. Kaituna Valley; leaf mould; R. R. Forster, 11/9/49; 1 specimen. Kowai Bush; under moss; J. Dugdale, 18/5/52; 2 specimens. Anticrow River; leaf mould; D. R. Cresswell, 10/1/51; 6 specimens. Craigieburn Cutting; leaf mould; C. Stokell, 6/11/49; 1 specimen. Cass; leaf mould; R. R. Forster, 10/7/49; 1 specimen. Avalanche Peak, Arthurs Pass; leaf mould; E. W. Dawson, 3/1/50; 1 specimen. (All specimens from Canterbury Museum).

Neochaeta salmoni n.sp. Figs. 250–253

Length 15 mm. Diameter 2 mm. 61 segments.

Colour dark brown with buff clitellum (in alcohol).

Clitellum xiii–½xviii, complete except for a small area on the ventral surface of xvii–xviii surrounding prostatic and male pores.

Prostomium tanylobous.

Chaetae 36/segment, arranged in pairs, not on yellow spots as in *N. forsteri.*

Prostatic pores on small papillae on xvii, in position of ventral-most pair of chaetae.

Male pores on anterior margin of xviii, in line with prostatic pores and anterior to ventral-most pair of chaetae. Seminal grooves absent.

Female pores on xiv, anterior to ventral-most pair of chaetae.

Spermathecal pores at 8/9, in line with ventral-most pair of chaetae.

Nephridiopores alternately ventro-lateral and lateral posterior to vi.

No specially thickened septa.

Pharynx in i–iv, large. Gizzard absent. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in xi, xii, those of xii larger than those of xi.

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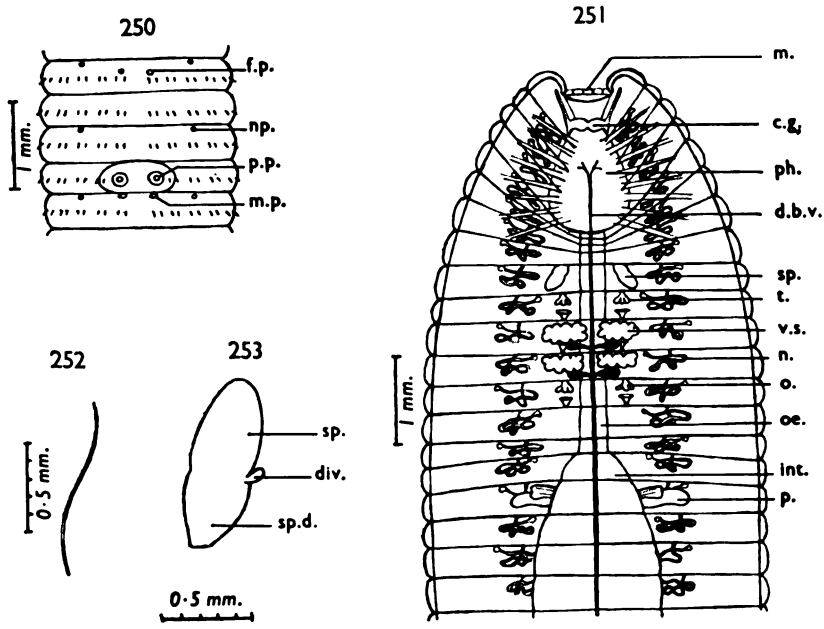

FIGS. 250–253. *Neochaeta salmoni* n.sp.
250. Ventral aspect, segments xiv–xviii
251. Dissection from dorsal aspect, segments i–xx
252. Penial chaeta
253. Right spermatheca, medial aspect

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, tubular, not coiled, small. Penial chaetae in xvii; long slender sigmoid shaft, terminating bluntly (Fig. 252). Spermathecae in ix; small sub-ovoid sac not sharply divided from long wide duct about same length as sac; very small tubular diverticulum opens into posterior aspect of spermatheca at junction of sac and duct. (Fig. 253).

Nephridia with small vesicles.

Type Locality: Near Desert Road, Waiouru; leaf mould; J. T. Salmon, 24/3/48.

Type specimen in Dominion Museum collection.

Localities:

North Island: Same data as type material; 1 specimen.

Genus NEODRILUS Beddard

1887 *Neodrilus* Beddard, Proc. roy. Soc. Edinb. 14:157.
1895 *Acanthodrilus* (part), Beddard, Monograph p. 527.
1899 *Neodrilus*, Michaelsen, Zool. Jahrb. Syst. 12:234.
1900 *Neodrilus*, Michaelsen, Tirreich 10:125.
1930 *Neodrilus*, Stephenson, Oligochaeta p. 827.

Small, active, brightly pigmented worms, living usually in forest litter. Chaetae 8 per segment. Clitellum developed over five to seven segments,

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between xii and xx. Prostatic pores one pair, on xvii (in *N. dissimilis* on xvi), not always on papillae. Male pores at anterior margin of xviii (in *N. dissimilis* at posterior margin of xvi). Female pores on xiv, paired, ventro-lateral. Spermathecal pores one pair, at 7/8 or 8/9, or near the anterior margin of viii. Nephridiopores alternately dorso-lateral and ventro-lateral (or lateral) except on the first few segments. Gizzard single, in v or vi. Dorsal blood vessel unpaired or paired but fusing at intersegmental septa; three or four pairs of hearts. Testes two pairs, in x, xi, not in testis sacs. Vesiculae seminales at least two pairs, in xi, xii (x, xi in *N. dissimilis*); sometimes also in ix or x. Prostates one pair, opening to the exterior in xvii (xvi in *N. dissimilis*). Penial chaetae present. Spermathecae in viii or ix (in *N. edwardsi* there are spermathecae in viii and ix, but those of viii are very small and apparently non-functional); diverticula present, usually projecting through the septum into the next anterior segment. Nephridial vesicles present.

Type species: *Neodrilus campestris* (Hutton).

Number of Species: Five.

Distribution: New Zealand; confined to southern North Island and eastern South Island districts. (Fig. 363).

The genus was proposed by Beddard (1887) for a species that he named *N. monocystis*. Benham (1899), in re-examining specimens of New Zealand earthworms described by Hutton (1877), found that the type material of Hutton's *Lumbricus campestris* consisted of specimens of Beddard's *Neodrilus monocystis* and three individuals of *Lumbricus rubellus*. In describing *Lumbricus campestris* Hutton had apparently listed most of the characters from specimens of *Neodrilus*, but had mixed with them characters from the specimens of *Lumbricus rubellus*. Because of Hutton's confusion of the characters of the two species, Benham (1899) did not recognise Hutton's specific name. However, Benham was wrong, and Hutton's specific name has precedence over Beddard's.

Three new species, *N. dissimilis*, *N. edwardsi*, and *N. polycystis*, are described in the present work, and *N. agilis* Lee (1949) is redescribed.

KEY TO THE SPECIES OF NEODRILUS

a$_1$ Gizzard confined to v
  b$_1$ Dorsal blood vessel unpaired; prostates in xvi ..... **N. dissimilis**
  b$_2$ Dorsal blood vessel paired, but the two vessels fusing at each septum; prostates in xvii ..... **N. edwardsi**
a$_2$ Gizzard confined to vi
  c$_1$ Spermatheca with single cylindrical diverticulum in next anterior segment ..... **N. campestris**
  c$_2$ Spermatheca with numerous diverticula, either in next anterior segment, or in same segment as sac
    d$_1$ Dorsal blood vessel unpaired; spermathecal diverticula in same segment as spermathecal sac ..... **N. agilis**
    d$_2$ Dorsal blood vessel paired posterior to xiii/xiv, but the two vessels fusing at each septum; spermathecal diverticula in next segment anterior to spermathecal sac ..... **N. polycystis**

The five species of *Neodrilus* inhabit forest litter in south-western North Island and northern and eastern South Island districts. Their distribution pattern closely resembles that of *Maoridrilus*; in the North

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TABLE 12. Neodrilus

——	*agilis*	*campestris*
Length	51 mm.	70 mm.
Diameter	3 mm.	6 mm.
Segments	118	155
Colour	greenish grey	olive green
Clitellum	xiii–xix	xiii–xix
Extent of clitellum	dorsal and lateral	xiv–xvii dorsal and lateral, elsewhere complete
Prostomium	tanylobous	tanylobous
Prostatic papillae	prominent, rounded	large, rounded
Position of prostatic pores ..	a/b	a
Position of male pores ..	near anterior margin of xviii a/b	middle of xviii, at end of seminal grooves
Position of female pores ..	antero-lateral to b	anterior to a
Position of spermathecal pores	7/8 a	anterior margin of viii a
Position of nephridiopores ..	b–c	b–c
First ventral nephridiopore ..	x	vii (or viii)
Septal thickening	absent	absent
Proventriculus	v	v
Gizzard	vi	vi
Nature of gizzard	small	large, strong
Oesophageal glands	xiv, xv	absent
1st intestinal segment ..	xvii	xv
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	4	4
Last heart	xiii	xiv
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xi, xii racemose	x, xi, xii racemose
Prostates	xvii–xxi	xvii–xxiv–xvii
Penial chaetae	present	present
Copulatory muscles	absent	absent
Position of spermathecae ..	viii	viii
Spermathecal diverticula:		
Number	numerous	1
Form	small swellings on spermathecal duct	truncated, cylindrical
Position	surround duct	anterior, in vii
Nephridial vesicles	present	present

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TABLE 12. Neodrilus—*continued*

dissimilis	*edwardsi*	*polycystis*
35 mm.	39 mm.	44 mm.
2·5 mm.	4·25 mm.	4·5 mm.
109	96	81
brick red	purplish brown, white spots at chaetae	reddish brown
xii–xvii	xiv–xx	xiv–½xix
dorsal and lateral	complete	dorsal and lateral
tanylobous	epilobous	tanylobous
absent, pores in small hollows	low, rounded	large, square, flattened
medial to a	a	a/b
posterior margin of xvi, at end of seminal grooves	anterior margin of xviii at end of seminal grooves	a/b on xviii, near end of seminal grooves
anterior to a	anterior to a	anterior to b
7/8	8/9	7/8
a	b	b
b–c	c–d	b–c
vi	xiii	ix
absent	absent	absent
absent	absent	v
v	v	vi
small	long, strong	small
xiii, xiv	xiii, xiv, xv	xiv, xv
xvii	xvii	xviii
unpaired	paired, fusing at septa	paired posterior to xiii/xiv, fusing at septa
3	3	4
xii	xii	xiii
dorsal b.v.	supra-intestinal v.	dorsal b.v.
x, xi	x, xi	x, xi
x, xi	xi, xii	xi, xii
racemose	botryoidal	racemose
xvi	xvii	xvii
present	present	present
absent	absent	absent
viii	viii, ix; viii<ix	viii
1	1	numerous
small, ovoidal	small, ovoidal	ovoidal
n vii; opens into duct	anterior, in next anterior segment	anterior, in vii
anteriorly		
present	present	present

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Island there is a concentration of species (*N. agilis, N. polycystis, N. dissimilis*) in the south-west, with one species (*N. edwardsi*) in west central districts, while in the South Island one species (*N. campestris*) is found in the south-east. The explanation of this distribution pattern is probably the same as that for the species of *Maoridrilus*, which have the same distribution pattern.

One species, *N. dissimilis* from Kapiti Island, differs from the remainder in having the prostates confined to xvi and opening to the exterior on xvi. Such a variation is probably of little significance since in all other respects *N. dissimilis* closely resembles the other species of the genus (see Table 12). *N. edwardsi,* in its possession of two pairs of spermathecae (a pair in viii and a pair in ix), also differs from the remainder of the species, and in this respect (and superficially in some other respects) resembles *Maoridrilus.* However, the spermathecae of viii are much smaller than those of ix, and I have been unable to find spermathecal pores corresponding to them, so it is probable that they are non-functional. Of the remaining three species, *N. agilis* and *N. polycystis* can only be distinguished systematically by minor anatomical differences, although morphologically they are quite distinct, *N. agilis* being a slender greenish grey worm, tapering gradually anteriorly and posteriorly, while *N. polycystis* is a short, stout, reddish brown worm, sharply truncated anteriorly and posteriorly. *N. campestris* resembles *N. agilis* and *N. polycystis* but is more easily distinguished, since it lacks oesophageal glands, has a large, strong gizzard while the other two species have small gizzards, and its spermathecae each have only one diverticulum while those of the other two species each have a number of diverticula.

Neodrilus agilis Lee. Figs. 254–257

1949 *Neodrilus agilis* Lee, Nature 163:951.

Length 51 mm. Diameter 3 mm. 118 segments.

Colour grey with greenish sheen, clitellum olive green.

Clitellum xiii–xix, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=dd≫ab; bc>aa.

Prostatic pores on prominent papillae on xvii, in position of chaetal interval ab.

Male pores near anterior margin of xviii, in line with prostatic pores, not in seminal grooves.

Female pores on xiv, antero-lateral to chaeta b.

Spermathecal pores at 7/8, in line with chaeta a.

Nephridiopores alternately anterior to chaetae b and c posterior to ix.

No specially thickened septa.

Pharynx in i–iv, with salivary glands attached to its posterior surface and extending back into v. Narrow thin-walled proventriculus in v. Gizzard in vi, small. Oesophageal glands in xiv, xv. Intestine commences in xvii and has a typhlosole which spirals slowly around the circumference of the intestine.

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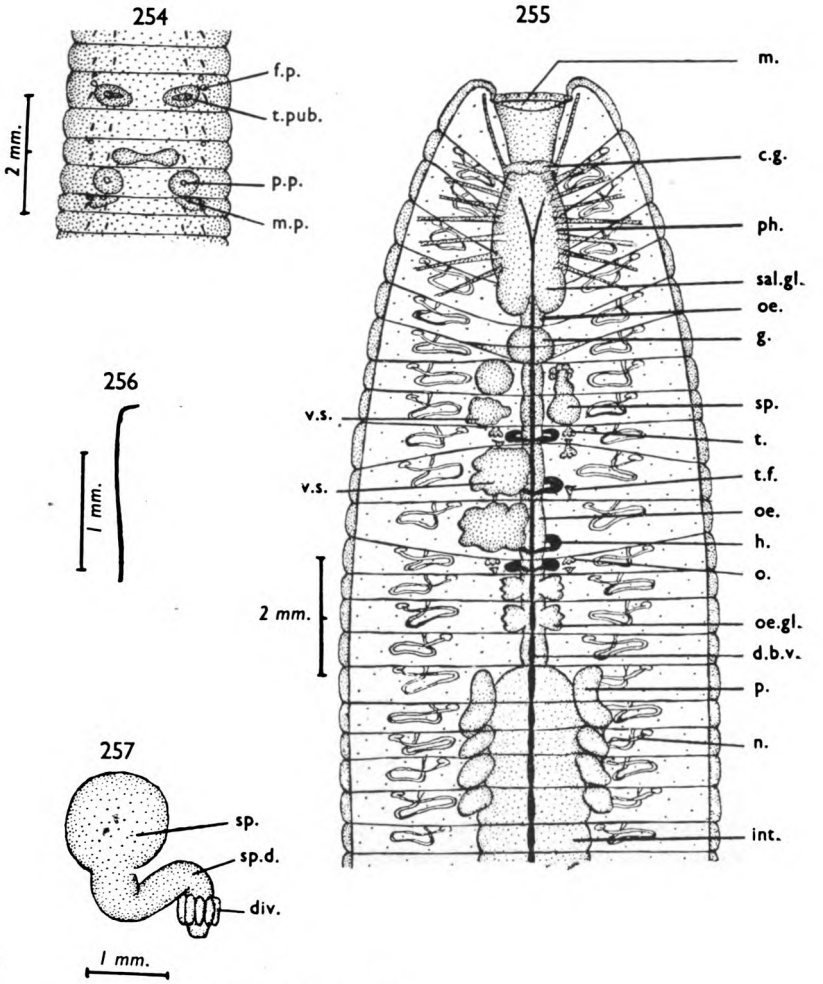
Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii. The blood is red in the living animal but turns green in alcohol-preserved specimens.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii–xxi, tubular, convoluted. Penial chaetae in xvii; long, gently curved shaft, sharply curved near tip and pointed (Fig. 256). Spermathecae in viii; large spheroidal sac with wide, convoluted duct; cluster of small diverticula in circle around duct. (Fig. 257).

Nephridia with vesicles; the nephridia are pale green in colour in alcohol-preserved specimens.



FIGS. 254–257. *Neodrilus agilis*
254. Ventral aspect, segments xiii–xix
255. Dissection from dorsal aspect, segments i–xxii
256. Penial chaeta
257. Left spermatheca, medial aspect

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Type Locality: Karori, Wellington; ex garden soil; K.E.L., 2/7/48. Type specimen in Dominion Museum collection.

Localities:

North Island: Same data as type material; 29 specimens. Kelburn, Wellington; ex garden soil; P. C. Alve, 1950; 2 specimens. Taita Soil Expt. Station; leaf mould, manuka scrub; K.E.L., 19/7/54; 1 specimen. Taita Soil Expt. Station; leaf mould, broadleaved forest; K.E.L., 8/48; 1 specimen. Turakirae Bay, Wellington; under stone; C. McCann, 15/11/52; 1 specimen.

Neodrilus campestris (Hutton). Figs. 258, 259

1877 *Lumbricus campestris* (part) Hutton, Trans. N.Z. Inst. 9:351.
1883 *Dygaster campestris* (part), Hutton, N.Z. J. Sci. 1:586.
1887 *Endrilus campestris* (part), Smith, Trans. N.Z. Inst. 19:137.
1887 *Neodrilus monocystis* Beddard, Proc. roy. Soc. Edinb. 14:158.
1889 *Neodrilus monocystis,* Beddard, Proc. zool. Soc. Lond., 1889, p. 380.
1890 *Neodrilus monocystis,* Benham, Quart. J. micr. Sci. 31:232.
1891 *Neodrilus monocystis,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1891 *Neodrilus monocystis,* Benham, Quart. J. micr. Sci. 33:289–94.
1892 *Neodrilus monocystis,* Beddard, Proc. zool. Soc. Lond., 1892, p. 667.
1895 *Acanthodrilus monocystis,* Beddard, Monograph p. 535.
1899 *Neodrilus monocystis,* Benham, Ann. Mag. nat. Hist., ser. 7, 3:138.
1899 *Neodrilus monocystis,* Michaelsen, Zool. Jahrb. Syst. 12:234.
1900 *Neodrilus monocystis,* Michaelsen, Tierreich 10:126.
1910 *Neodrilus monocystis,* Michaelsen, Mitt. zool. Mus. Hamb. 27:71–2.
1937 *Neodrilus monocystis,* Pickford, Monograph pp. 91, 603.

Length c.70 mm. Diameter c.6 mm. 155 segments; the body is almost square in cross section.

Colour sienna brown with buff clitellum (in ethyl alcohol); olivaceous green when alive (Benham 1899).

Clitellum xiii–xix, dorsal only on xiii, dorsal and lateral on xiv–xvii, complete on xviii–xix.

Prostomium tanylobous.

Chaetae 8/segment, closely paired, pairs evenly spaced around segments.

Prostatic pores on conspicuous rounded papillae on xvii, in position of chaeta a.

Seminal grooves extend back from xvii–xviii, bordered by prominent ridge. Male pores at posterior ends of seminal grooves, in position of chaeta a.

Female pores on xiv, ventro-lateral.

Spermathecal pores at anterior margin of viii, in line with chaeta a.

Nephridiopores alternately in line with chaetae b and c posterior to vi or vii.

No specially thickened septa.

Gizzard in vi. Oesophageal glands absent. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in xi, xii, xiii, xiv.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii, racemose. Prostates in xvii–xxiv–xvii, tubular, convoluted, very large. Penial chaetae in sac extending straight back through xvii–xxiii; elongate, slender, gently curved shaft, sharply bent distally and terminating in a sharp point; tip of chaeta ornamented with numerous minute spines (Figs. 258, 259). Spermathecae in viii; large, thick-walled

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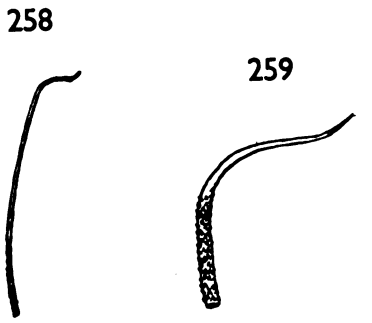
ovoidal sac in viii, opening by short thick duct; diverticulum in vii, about same size as sac, roughly cylindrical and truncated, opening by a short duct through septum vii–viii into anterior aspect of spermathecal duct.

Nephridial vesicles present.

Type Locality: Dunedin; F. W. Hutton, 1877.

Type material in Otago Museum (No. A.56.20); 2 specimens, in good condition.

Previous Records:



FIGS. 258, 259. *Neodrilus campestris*
258. Penial chaeta
259. Tip of penial chaeta
(Drawings after Benham, 1891)

South Island: Mt. Peel; W. W. Smith, 1887. Dunedin; W. B. Benham, 1890.

Neodrilus dissimilis n.sp. Figs. 260–263

Length 35 mm. Diameter 2·5 mm. 109 segments.

Colour brick red dorsally, pale ventrally, with prominent clitellum.

Clitellum xii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment: aa=dd; bc>aa>cd>ab.

Prostatic pores in small dark hollow areas on xvi, slightly medial to position of chaeta a.

Seminal grooves pass back from prostatic pores to posterior margin of xvi. Male pores at posterior end of seminal grooves, slightly lateral to line of chaeta a.

Female pores on xiv, slightly anterior to chaeta a.

Spermathecal pores at 7/8, in line with chaeta a.

Nephridiopores alternately anterior to chaetae b and c posterior to v.

No specially thickened septa.

Pharynx in i–iv. Gizzard in v, not strongly muscular. Oesophageal glands in xiii, xiv. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, racemose. Prostates in xvi, broad, tubular convoluted. Penial chaetae in xvi; stout, gently curved shaft, swollen near tip and sharply pointed (Fig. 262). Spermathecae in viii; small spherical sac opening by long, wide, muscular duct; small ovoidal diverticulum in vii opens into spermathecal duct by fairly wide duct which passes through septum vii/viii. (Fig. 263).

Nephridia with long tubular vesicles.

Type Locality: E. Coast of Kapiti Island, 1 mile S. of caretaker's house; leaf mould and shingle, coastal forest; K.E.L., 28/1/54.

Type specimen in Soil Bureau collection.

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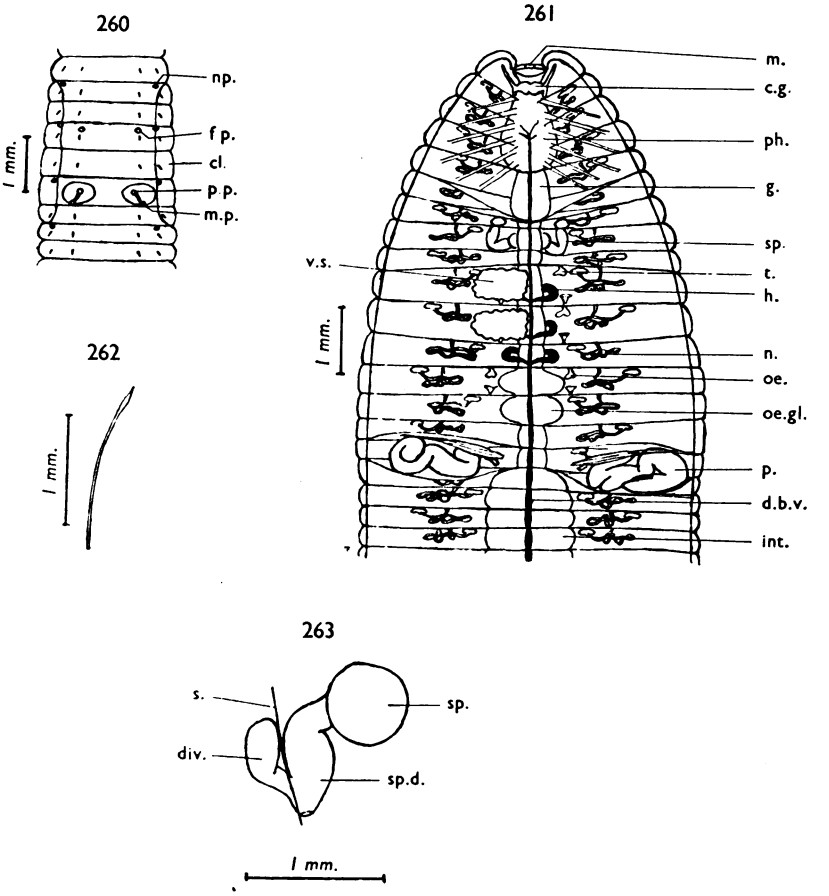
Localities:

Kapiti Island: Same data as type material; 4 specimens. E. coast of island, near N. end, steep slope 30 ft. above sea level; litter and shingle, coastal forest; K.E.L., 27/1/54; 4 specimens.

Remarks: This species is analogous to Benham's *Leptodrilus leptomerus* and *Leptodrilus magneticus,* which he separated from *Rhododrilus* because the prostatic pores were on xvi instead of xvii. A difference of this nature, when the species otherwise closely resembles other species of the genus, does not justify the establishment of a new genus.



FIGS. 260–263. *Neodrilus dissimilis* n.sp.
260. Ventral aspect, segments xi–xix
261. Dissection from dorsal aspect, segments i–xx
262. Penial chaeta
263. Right spermatheca, antero-medial aspect

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Neodrilus edwardsi n.sp. Figs. 264–267

Length 39 mm. Diameter 4·25 mm. 96 segments.

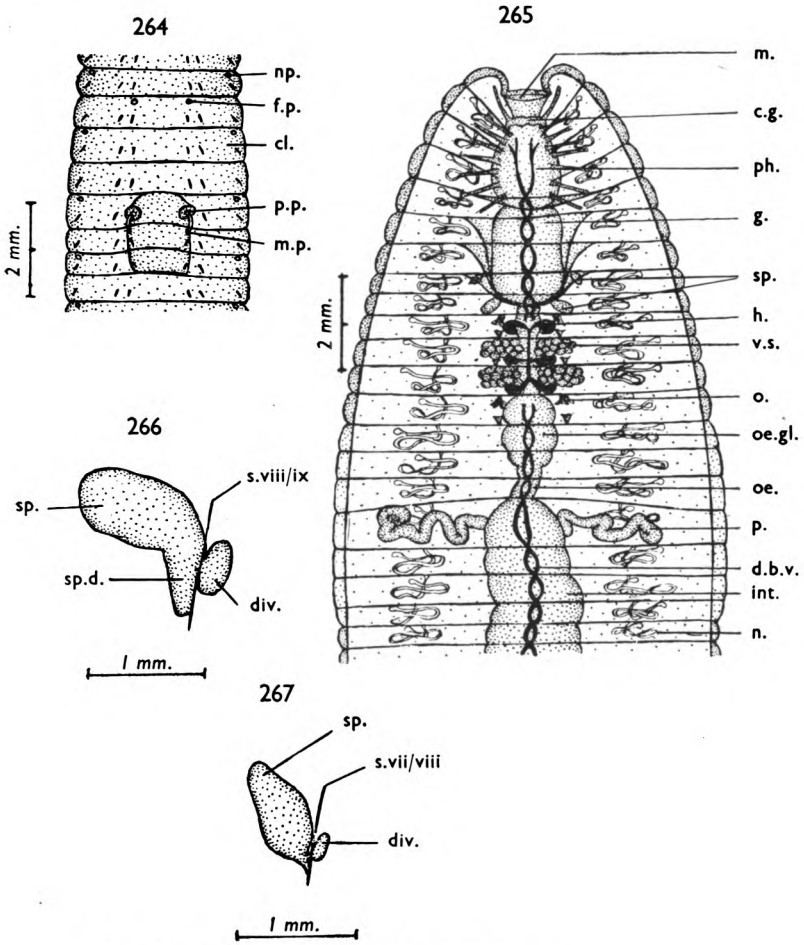
Colour purplish brown with buff clitellum (in ethyl alcohol); a round, white, raised papilla surrounds each chaeta.

Clitellum xiv–xx, complete.

Prostomium epilobous.

Chaetae 8/segment: aa=bc=cd⩾ab; dd>aa.

Prostatic pores on xvii, in line with chaeta a, on low, rounded papillae, on the edges of a median ventral depression, which extends over xvii–xix.



FIGS. 264–267. *Neodrilus edwardsi* n.sp.
264. Ventral aspect, segments xiii–xx
265. Dissection from dorsal aspect, segments i–xxi
266. Right posterior spermatheca
267. Right anterior spermatheca

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Seminal grooves extend from prostatic pores along the edges of the median ventral depression to the anterior margin of xviii, where the male pores are situated.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 8/9, in line with chaeta b.

Nephridiopores alternately anterior to chaeta c and chaeta d (i.e. lateral and dorso-lateral), posterior to xii.

No specially thickened septa.

Pharynx in i–iv. Gizzard in v, long, thick walled. Oesophageal glands in xiii, xiv, xv, those of xv smaller than those of xiii, xiv. Intestine commences in xvii.

Dorsal blood vessel paired but the two vessels fuse at each septum. Unpaired supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi, each consisting of a number of filiform processes. Ovaries in xiii, similar in form to testes. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii, elongate, tubular, convoluted. Penial chaetae in xvii; elongate, gently curved spine without ornamentation. Spermathecae in viii, ix; those of ix consist of a cylindrical sac with a wide muscular duct opening to the exterior and a small ovoidal diverticulum, situated in viii and opening through septum viii/ix into the spermathecal duct (Fig. 266): those of viii are about a third the size of those of ix, rather similar in form (Fig. 267), but appear to be non-functional as no external pores corresponding to them were found.

Nephridia with vesicles.

Type Locality: Mt. Egmont, near Jackson's Lookout, 3,800 ft.; leaf mould; J. S. Edwards, 11/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Mt. Egmont, 3,000 ft.; leaf mould, forest; J. S. Edwards, 11/51; 2 specimens. Mt. Egmont, 3,200 ft.; beside stream; J. S. Edwards, 11/51; 4 specimens. Tahurangi, Mt. Egmont, 3,200 ft.; leaf mould, forest; T. E. Woodward, 14/11/51; 1 specimen. Chateau Tongariro; ex moss; R. R. Forster, 18/12/48; 4 specimens.

Remarks: Superficially this species might be taken for a *Maoridrilus*, as the medial ventral depression on xvii–xix is characteristic of a number of species of *Maoridrilus*. The possession of two pairs of spermathecae is also a characteristic shared with *Maoridrilus* and with no other species of *Neodrilus*, although in the present species the anterior pair of spermathecae is apparently non-functional.

Neodrilus polycystis n.sp. Figs. 268–271

Length 44 mm. Diameter 4·5 mm. 81 segments; almost square in cross section with pairs of chaetae on corners of square in each segment.

Colour reddish brown dorsally and ventrally, with buff clitellum. Clitellum xiv–½xix, dorsal and lateral.

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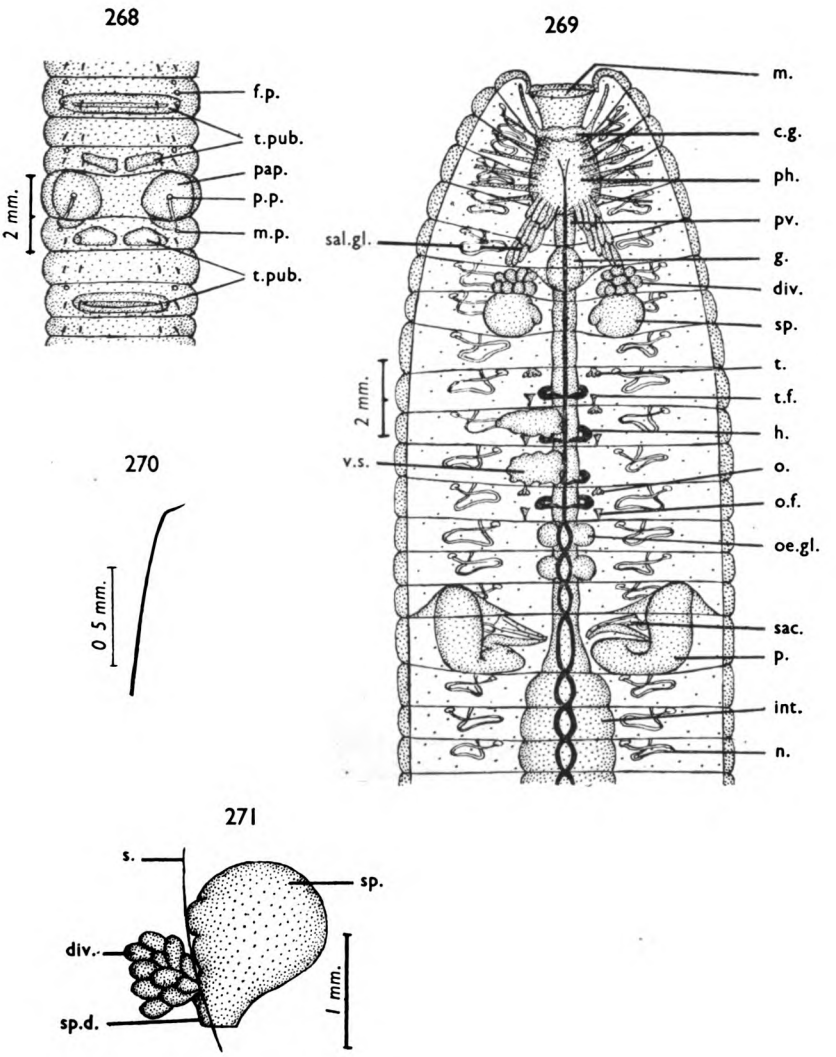
Prostomium tanylobous.

Chaetae 8/segment: ab=cd; aa=dd; bc>aa>ab.

Prostatic pores on xvii on very large squarish papillae, in line with chaetal interval ab. Seminal grooves run back from prostatic pores to posterior margin of xvii but are not continued onto xviii. There is a small tuberculum pubertatis across the posterior end of each seminal groove, at the anterior margin of xviii, and the male pores are against the posterior margins of these tubercula, in line with the prostatic pores.



FIGS. 268–271. *Neodrilus polycystis* n.sp.
268. Ventral aspect, segments xiv–xx
269. Dissection from dorsal aspect, segments i–xx
270. Penial chaeta
271. Right spermatheca, medial aspect

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Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 7/8, in line with chaeta b.

Nephridiopores alternately anterior to chaetae b and c posterior to viii.

Very prominent tubercula pubertatis on xiv, xvi, xviii, xx; those of xiv and xx are unpaired lateral bands extending across the ventral surface from chaeta b to chaeta b, while those of xvi and xviii occupy the same area but are divided into two halves along the ventral mid line.

No specially thickened septa.

Pharynx in i–iv; posterior dorsal aspect covered with salivary glands which extend back into v. Short narrow proventriculus in v. Gizzard in vi, small. Oesophageal glands in xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired anterior to xiii/xiv; paired posterior to xiii/xiv, but the two vessels fuse at each septum. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xvii, very wide tubular organs, slightly coiled. Penial chaetae in xvii; long, gently curved shaft, sharply curved near tip and pointed (Fig. 270). Spermathecae in viii; large spheroidal sac with short, wide, muscular duct; cluster of small diverticula in vii open through septum vii/viii into anterior aspect of spermathecal duct. (Fig. 271).

Nephridia with small vesicles.

Type Locality: Bank of Tauherenikau R., Tararua Ra.; leaf mould; P. Gardner, 17/4/48.

Type specimen in Dominion Museum collection.

Localities:

North Island: Silverstream, Wellington; leaf mould, forest; R. K. Dell, 20/5/50; 4 specimens.

Genus Plagiochaeta Benham

1891 *Plagiochaeta* Benham, Quart. J. micr. Sci. 33:308.
1900 *Plagiochaeta,* Michaelsen, Tierreich 10:126.
1930 *Plagiochaeta,* Stephenson, Oligochaeta p. 827.

Small, active, darkly pigmented worms usually found in leaf mould and under logs and stones in forest. Chaetae numerous (more than 12) per segment. Clitellum developed over four or five segments between xiii and xviii, complete at least anteriorly. Prostatic pores two pairs, on xvii, xix; on small papillae in *P. lineata,* otherwise papillae absent. Seminal grooves absent in *P. sylvestris,* otherwise present. Male pores one pair, on xviii, in seminal grooves if present. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two pairs, at 7/8, 8/9. Nephridiopores alternately dorso-lateral and ventro-lateral on all but the first few segments. Gizzard single, in v or vi, weakly developed. Oesophageal glands one pair, in xiv. Dorsal blood vessel unpaired, at least anteriorly (in one species paired posterior to xiv/xv); three or

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TABLE 13. Plagiochaeta

——	*lineata*	*stewartensis*	*sylvestris*
Length	35–50 mm.	25–30 mm.	42 mm.
Diameter	3 mm.	4 mm.	5 mm.
Segments	70–90	80	89
Colour	pink	reddish brown, white spots round chaetae	chocolate brown, white spots round chaetae
Clitellum	xiv–xvii	xiii–xvii	xiv–xviii
Extent of clitellum ..	xiv–xv complete xvi–xvii dorsal and lateral	complete except for small mid ventral area	complete
Prostomium	tanylobous	epilobous	tanylobous
Chaetae/segment ..	c. 50 in pairs	30–34 in pairs	30–54 in pairs
Prostatic papillae ..	small, rounded	absent	absent
Position of prostatic pores	ventro-lateral	a/b	a/b
Position of male pores ..	ventro-lateral, in seminal grooves	lateral to b, in seminal grooves	anterior to a/b
Position of female pores	anterior, close to ventral mid line	antero-lateral to a	anterior, close to ventral mid line
Position of spermathecal pores	7/8, 8/9 ventro-lateral	7/8, 8/9 a/b	7/8, 8/9 a/b
Position of nephridiopores	dorso-lateral and ventro-lateral	dorso-lateral and ventro-lateral	dorso-lateral and ventro-lateral
Septal thickening ..	absent	ix/x–xi/xii (slight)	xiii/xiv–xv/xvi (slight)
Proventriculus ..	v	absent	v
Gizzard	vi	v	vi
Nature of gizzard ..	very small	small	weakly developed
Oesophageal glands ..	xiv (+part xiii)	xiv	xiv
1st intestinal segment ..	xvi	xvi	xvi
Dorsal blood vessel ..	unpaired	unpaired	paired posterior to xiv/xv
Hearts (pairs)	3	4	3
Last heart	xii	xiii	xii
Origin of hearts ..	dorsal b.v.	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi	x, xi
Vesiculae seminales ..	ix, xi, xii racemose	xi, xii racemose	ix, x, xi, xii racemose
Penial chaetae.. ..	present	present	present
Copulatory muscles ..	absent	absent	absent
Spermathecal diverticula:			
Number	2	2 (fused at base)	1
Form	1 ovoidal 1 divided into 3 lobes	1 large, cornuiform 1 smaller, divided into 5 lobes	long, curved, tubular
Position	1 antero-lateral 1 antero-medial	medial	anterior
Nephridial vesicles ..	present	present	present

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four pairs of hearts, the last in xii or xiii. Testes two pairs, in x, xi, not in testis sacs. Vesiculae seminales always present in xi, xii, sometimes also in ix or ix and x. Prostates two pairs, in xvii, xix, each confined to one segment. Penial chaetae present. Copulatory muscles absent. Spermathecae two pairs, in viii, ix; diverticula present. Nephridial vesicles present.

Type species: *Plagiochaeta sylvestris* (Hutton).

Number of Species: Three.

Distribution: New Zealand, confined to western and southern districts of the South Island and to Stewart Island. (Fig. 363).

KEY TO THE SPECIES OF PLAGIOCHAETA

a$_1$ Gizzard confined to v; last pair of hearts in xiii..... **P. stewartensis**
a$_2$ Gizzard confined to vi; last pair of hearts in xii
  b$_1$ Dorsal blood vessel unpaired throughout its length; spermathecae with two diverticula, one antero-lateral, one antero-medial..... **P. lineata**
  b$_2$ Dorsal blood vessel paired posterior to xiv/xv; spermatheca with one long, curved, tubular, anterior diverticulum..... **P. sylvestris**

Plagiochaeta inhabits the southern end of the range of the tribe Neodrilacea, i.e. the southern portion of the South Island and Stewart Island. *P. lineata* and *P. sylvestris* are fairly widely distributed in the South Island, while *P. stewartensis* is common on Stewart Island but has been recorded only once from the South Island, at Bluff, adjacent to Stewart Island. The three species form a compact group and may be distinguished only by small anatomical differences. It seems likely that the genus originated in the south-west of the South Island, survived there in isolation during the Pleistocene cold period, and has since spread out again through the forests as they re-covered much of the area formerly covered by ice.

Anatomically *P. lineata* is closer to *P. sylvestris* (the type species) than is *P. stewartensis* (see Table 13).

Plagiochaeta lineata (Hutton). Figs. *272, 273*

1877 *Megasolex lineatus* Hutton, Trans. N.Z. Inst. 9:350–3.
1891 *Perichaeta lineata,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1895 *Megascolex lineatus* sp. inc. sed., Beddard, Monograph p. 369.
1899 *Plagiochaeta lineata,* Benham, Ann. Mag. nat. Hist., ser. 7, 3:137.
1900 *Plagiochaeta lineata,* Michaelsen, Tierreich 10:127.
1903 *Plagiochaeta lineatus,* Benham, Trans. N.Z. Inst. 35:281.
1913 *Plagiochaeta lineatus,* Benham & Cameron, Trans. N.Z. Inst. 45:192.
1923 *Plagiochaeta lineata,* Michaelsen, Videnskab. Medd. dansk. naturh. Foren. Kbh. 75:223.
1937 *Plagiochaeta lineata,* Pickford, Monograph pp. 91, 604.

Length 35–50 mm. Diameter 3 mm. 70–90 segments.

Colour pink, fairly uniform dorsally and ventrally, with pale brown clitellum.

Clitellum xiv–xvii, complete on xiv–xv, dorsal and lateral on xvi–xvii.

Prostomium tanylobous.

Chaetae c.50/segment, arranged in pairs.

Prostatic pores on small papillae on xvii, xix, ventro-lateral.

Male pores in seminal grooves on xviii, in line with prostatic pores.

Female pores on xiv, close to ventral mid line.

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Spermathecal pores at 7/8, 8/9, ventro-lateral.

Nephridiopores alternately dorso-lateral and ventro-lateral.

Proventriculus in v. Gizzard in vi, very small. Oesophageal glands in xiv (extending forward into xiii). Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, racemose. Prostates in xvii, xix, tubular, convoluted. Penial chaetae long, slender, gently curved; tip bent more sharply, slightly spoon-shaped, with transverse, low, finely serrated ridges encircling shaft (Fig. 272). Spermathecae in viii, ix; sac ovoidal with short, narrow duct; two diverticula, one ovoidal the other divided into three small lobes, open into spermathecal duct. (Fig. 273).

Nephridial vesicles present.

Type Locality: Queenstown; F. W. Hutton, 1877.

Type material in Otago Museum (No. A.56.22); 3 specimens, 1 complete, 2 in fragments, preservation poor.

Localities:

South Island: Lake Paringa, S. Westland; leaf mould, forest; P. Hughson, 23/10/50; 10 specimens. Cascade Creek; ex moss; R. R. Forster, 23/1/51; 1 specimen. Takahe Valley, near L. Te Anau; P. C. Bull, 20/2/54; 2 specimens.

Previous Records:

Queenstown; W. B. Benham, 1902.

Plagiochaeta stewartensis Michaelsen. Figs. 274–276

1923 *Plagiochaeta stewartensis* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:223–6.

1937 *Plagiochaeta stewartensis,* Pickford, Monograph p. 91.

Length 25–30 mm. Diameter c.4 mm. c.80 segments.

Colour reddish brown dorsally and ventrally, with darker streak along dorsal mid line; small pale spot surrounds each pair of chaetae.

Clitellum xiii–xvii, not quite complete.

Prostomium epilobous.

Chaetae 30–34/segment, in pairs fairly evenly spaced.

Prostatic pores on small pale spots (not on definite papillae) on xvii, xix, in line with chaetal interval ab. Seminal grooves shallow, with slight lateral curve across xviii.

Male pores in seminal grooves on xviii, slightly lateral to chaeta b.

Female pores anterior and slightly lateral to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores alternately dorso-lateral and ventro-lateral.

Septa ix/x to xi/xii slightly thickened.

Gizzard in v, small. Oesophagus dilated in ix, x, xi, xii; one pair of oesophageal glands in xiv. Intestine commences in xvi. Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose, Prostates in xvii, xix, tubular, coiled. Penial chaetae with long slender shaft, sharply recurved distally and slightly hollowed out at

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the tip (Figs. 274, 275). Spermathecae in viii, ix; large ovoidal sac with short narrow duct; two diverticula fused at their point of entry into the spermathecal duct, one large and cornuiform, the other smaller and divided into five lobes. (Fig. 276).

Nephridial vesicles present.

Type Locality: Stewart Island; under wood and stones; W. Michaelsen, 1923.

Type specimen in University Zoological Museum, Copenhagen, Denmark.

Localities:

South Island: Bluff; under logs; J. H. Sorensen, 18/5/49; 2 specimens. Stewart Island: Halfmoon Bay; leaf mould; O. Allen, 11/3/49; 11 specimens. Mt. Rakeahua; leaf mould; E. W. Dawson, 30/1/51; 1 specimen. Halfmoon Bay; leaf mould; G. A. Knox, 10/1/51; 1 specimen. (All specimens from Canterbury Museum collections).

Plagiochaeta sylvestris (Hutton). Figs. 277, 278

1877 *Megasolex sylvestris* Hutton, Trans. N.Z. Inst. 9:352.
1887 *Megalosolex sylvestris,* Smith, Trans. N.Z. Inst. 19:137–8.
1891 *Perichaeta sylvestris,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1891 *Plagiochaeta punctata* Benham, Quart. J. micr. Sci. 33:289.
1892 *Megascolex* (=*Plagiochaeta*?) *sylvestris,* Beddard, Proc. zool. Soc. Lond., 1892, p. 667.
1895 *Megascolex sylvestris* sp. inc. sed., Beddard, Monograph p. 369.
1895 *Plagiochaeta punctata,* Beddard, Monograph p. 558.
1899 *Plagiochaeta sylvestris,* Benham, Ann. Mag. nat. Hist., ser. 7, 3:137.
1900 *Plagiochaeta sylvestris* + *Plagiochaeta punctata,* Michaelsen, Tierreich 10:126–7.
1903 *Plagiochaeta sylvestris,* Benham, Trans. N.Z. Inst. 35:277–90.
1904 *Plagiochaeta sylvestris,* Benham, Proc. zool. Soc. Lond, 1904 (2), p. 229.
1913 *Plagiochaeta sylvestris,* Benham & Cameron, Trans. N.Z. Inst. 35:277–90.
1923 *Plagiochaeta sylvestris* + *Plagiochaeta punctata,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:223.
1937 *Plagiochaeta sylvestris,* Pickford, Monograph pp. 91, 604–5.
1942 *Plagiochaeta punctata,* Benham, Trans. roy. Soc. N.Z., 72:221.

Length 42 mm. Diameter c.5 mm. 89 segments.

Body depressed dorso-ventrally.

Colour chocolate brown with small white spot surrounding each pair of chaetae.

Clitellum xiv–xviii, complete.

Prostomium tanylobous.

Chaetae very numerous, in pairs; 15–27 pairs per segment.

Prostatic pores on xvii, xix, not on papillae; small, transverse, slit-like apertures, in line with chaetae ab. Seminal grooves absent.

Male pores on xviii, anterior to chaetae ab.

Female pores close to ventral mid line on xiv, near anterior margin of segment.

Spermathecal pores at 7/8, 8/9, in line with chaetae ab.

Nephridiopores alternately dorso-lateral and ventro-lateral.

Septa xiii/xiv to xv/xvi slightly thickened.

Gizzard in vi, very weakly developed. Oesophageal glands in xiv, large. Intestine commences in xvi.

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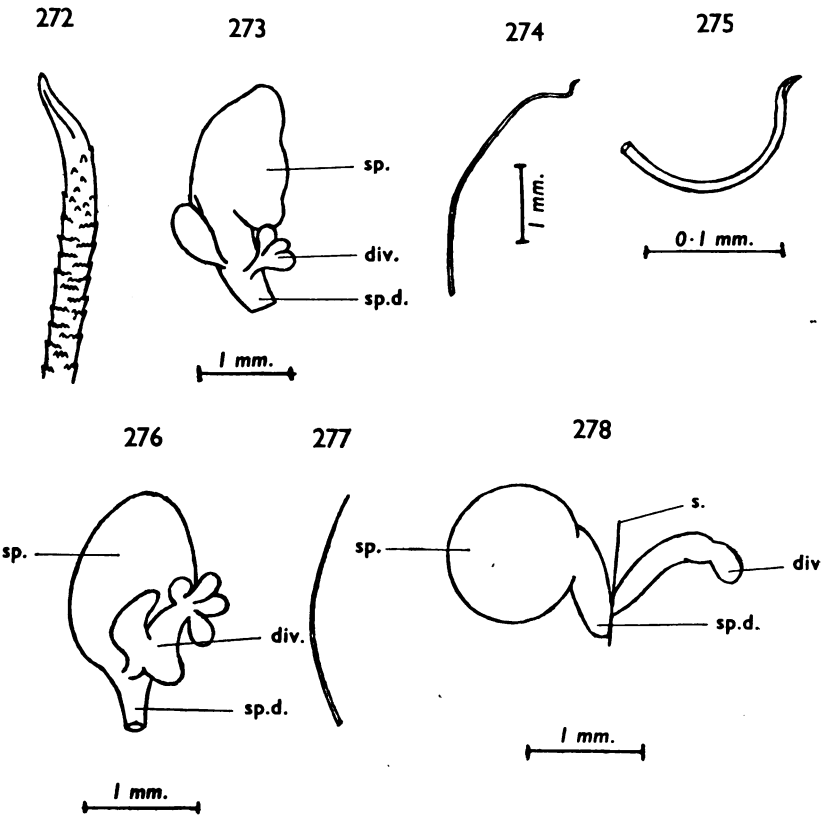
Dorsal blood vessel paired posterior to xiv/xv, unpaired anterior to xiv/xv. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xvii, xix tubular, slightly convoluted. Penial chaetae with long gently curved shaft, more sharply curved near tip, with fine point; no ornamentation on shaft. (Fig. 277). Spermathecae in viii, ix; large, sub-globular sac with long duct; long, curved, tubular diverticulum in next anterior segment, opening through septum into anterior aspect of spermathecal duct. (Fig. 278).

Nephridia with vesicles.



FIGS. 272, 273. *Plagiochaeta lineata*
272. Tip of penial chaeta
273. Spermatheca
(Drawings after Benham, 1903b)

FIGS. 274–276. *Plagiochaeta stewartensis*
274. Penial chaeta
275. Tip of penial chaeta
276. Spermatheca
(Drawings after Michaelsen, 1923a)

FIGS. 277, 278. *Plagiochaeta sylvestris*
277. Penial chaeta
278. Spermatheca
(Drawings after Benham, 1891)

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Type Locality: Dunedin; in rotten wood; F. W. Hutton, 1877.

Type specimens in Otago Museum collection (No. A.56.23); 3 specimens, 1 complete, 2 in fragments, in poor condition.

Localities:

South Island: Bluff; leaf mould, forest; J. H. Sorensen, 17/5/49; 1 specimen. Orepuki; leaf mould, forest; R. R. Forster, 9/5/49; 8 specimens. Oparara; leaf mould, forest; R. R. Forster, 20/1/50; 4 specimens. Mt. Davie; leaf mould, forest; R. R. Forster, 18/1/50; 11 specimens. Lake Mahinapua Forest Reserve, Westland; leaf mould, forest; K.E.L., 16/1/53; 1 specimen. Takahe Valley, Te Anau; P. C. Bull, 20/2/54; 3 specimens.

Previous Records:

Dunedin; F. W. Hutton, 1877. Dunedin; W. B. Benham, 1903. Mangatua; W. B. Benham, 1903. Peel Forest; leaf mould and under bark and in logs; W. W. Smith, 1887.

INCERTAE SEDIS

Octochaetus levis (Hutton)

1877 *Lumbricus levis* (part) Hutton, Trans. N.Z. Inst. 9:351.
1883 *Dygaster? levis,* Hutton, N.Z. J. Sci. 1:585.
1887 *Endrilus levis* (part), Smith, Trans. N.Z. Inst. 19:136.
1889 *Lumbricus (Allolobophora) levis,* Vaillant, Hist. nat. Annel. 3 (1):144.
1891 *Digaster laevis* (part), Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1899 *Octochaetus levis,* Benham, Ann. Mag. nat. Hist., ser. 7, 3:137.
1900 *Octochaetus levis,* Michaelsen, Tierreich 10:321.
1905 *Octochaetus levis,* Ude, Z. wiss. Zool. 83.
1950 *Octochaetus levis,* Benham, Trans. roy. Soc. N.Z. 78:235.
1952 *Octochaetus levis,* Lee, Trans. roy. Soc. N.Z. 79:559.

The description given by Hutton (1876) is insufficient for the recognition of the species. Benham (1899) re-examined Hutton's type material and concluded that the species could be referred "with the greatest probability to the genus *Octochaetus.*" In a second container, also labelled *Lumbricus levis* by Hutton, Benham found a specimen of *Allolobophora caliginosa.* When writing his description of "*Lumbricus levis*" Hutton had apparently described some characters from each of the species in the tubes.

The following is a partial diagnosis of the species, derived from the descriptions of Hutton (1877), with some additions from Benham (1899):

Length c.35 mm. 130–150 segments.

Colour pale pink.

Clitellum xiv–xix.

Chaetae 8/segment: ab=cd; aa=dd; aa>bc>ab.

Spermathecal pores at 7/8, 8/9.

Dorsal blood vessel paired.

Spermathecae in viii, ix, each with a single, small, rounded diverticulum in the same segment as the spermathecal sac.

Type Locality: Hampden; F. W. Hutton 1877.

Type specimen in Otago Museum. (No. A.56.21). I have examined the single specimen, but it is in two parts and is so brittle that it cannot be handled.

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Octochaetus microchaetus (Benham)

1950 *Cryptochaeta microchaeta* Benham, Trans. roy. Soc. N.Z. 78:324.
1952 *Octochaetus microchaetus,* Lee, Trans. roy. Soc. N.Z. 79:558.

The species described under the name of *Cryptochaetus microchaetus* was based on a single specimen, collected long ago, which was in the possession of the late Sir William Benham. The description given by Benham is insufficient for the recognition of the species, but it is probably a species of *Octochaetus.*

The following is Benham's description:

Length 150 mm. Diameter 5 mm.
Clitellum xii–xx.
Prostomium epilobous.
Chaetae 8/segment: very small, closely paired.
Prostatic pores on xvii, xix.
Gizzard in vii. Oesophagus dilated in xiii, xiv, xv.
Prostates tubular.
Spermatheca globular with mulberry-like diverticulum.
Micronephric.

Type Locality: Hampden.

The type specimen of this species has not been located.

Rhododrilus monticola (Beddard)

1895 *Microscolex monticola* Beddard, Monograph p. 467.
1900 *Microscolex monticola,* Michaelsen, Tierreich 10:143.
1901 *Microscolex monticola,* Benham, Trans. N.Z. Inst. 33:142.
1907 *Rhododrilus monticola,* Michaelsen, Fauna Südwest-Aust. 1 (2):142.
1937 *Rhododrilus monticola,* Pickford, Monograph pp. 89, 594.

This species has not yet been satisfactorily described, for even the most complete description (Beddard, 1895) is insufficient for recognition of the species. Pickford (1937) saw a cotype from the British Museum but described only the nephridial vesicles. I have been unable to find any more specimens.

The following is Beddard's description:

Length 31 mm. Diameter 3 mm. 79 segments.
Colour black with chaetae on white spots.
Clitellum absent.
Chaetae 8/segment, in pairs: cd>ab.
Prostatic and male pores on xvii.
Spermathecal pores at 8/9.
Nephridiopores in single series on each side.
Gizzard in viii.

Testes in x, xi. Vesiculae seminales in xii. Prostates tubular, long and coiled. Spermathecae in ix, with two diverticula. (Pickford (1937) stated that the nephridia have long tubular vesicles.)

Type Locality: Mt. Pirongia, W. Waikato.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

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Maoridrilus intermedius Michaelsen. Fig. 279

1923 *Maoridrilus intermedius* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:221–3.
1937 *Maoridrilus intermedius,* Pickford, Monograph p. 91.

Michaelsen's description of this species does not include sufficient detail to enable it to be positively distinguished from a number of species of *Maoridrilus.* There can be little doubt that a systematist of Michaelsen's standing was correct in his identification of the species as a member of the genus *Maoridrilus,* but there is no alternative but to include it as *incertae sedis.*

The following is a summary of Michaelsen's description of the species, together with a sketch of the spermatheca, copied from Michaelsen:

Length c.170 mm. Diameter c.7 mm. c.240 segments.

Colour dark violet dorsally, changing to smoke brown ventrally.

Chaetae 8/segment: aa=bc; dd>aa; aa≫ab.

Prostatic pores on xvii, xix, on medially flattened papillae which occupy the whole length of the segments; those of xvii in line with chaetal interspace ab, those of xix slightly medial to line of chaeta a.

Male pores in seminal grooves, on xviii.

Spermathecal pores at 7/8, 8/9.

Gizzard large and strong.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, compact, sac-like. Prostates in xvii, xix, tubular, convoluted. Spermathecae in viii, ix, those of viii smaller than those of ix; irregular flattened ovate sac with wide, short, slightly arched duct; small ovoidal diverticulum fused with spermathecal duct at junction with sac and projecting downwards beside spermathecal duct. (Fig. 279).

Type Locality: Plimmerton; W. Michaelsen, 1923.

Type specimen in University Zoological Museum, Copenhagen, Denmark.

Maoridrilus mauiensis Benham. Figs. 280, 281

1904 *Maoridrilus mauiensis* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 222–4.
1905 *Maoridrilus mauianus,* Benham, Trans. N.Z. Inst. 37:282.
1937 *Maoridrilus mauiensis,* Pickford, Monograph p. 91.

Benham's original description of this species was based on a single incomplete specimen, collected by H. Suter in 1899. The species has not been re-collected since Benham first described it, and since his description is incomplete it is not possible to identify the species. The following is a summary of Benham's description:

Length of fragment 80 mm. Diameter 4 mm. 117 segments.

Colour pale yellowish (in alcohol).

Clitellum not developed.

Prostomium tanylobous.

Chaetae 8/segment, closely paired: bc=dd>aa; aa≫ab.

Prostatic pores on xvii, xix, on papillae, in line with chaetal interval ab.

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Male pores in seminal grooves on xviii, between chaetae a and b. Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab. Septa viii/ix to xiv/xv thickened.

Gizzard large. Oesophageal glands in xiii, xiv, xv, those of xv smaller than those of xiii, xiv.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, botryoidal. Prostates in xvii, xix, tubular, convoluted. Penial chaetae "S"-shaped, tip spoon-shaped, but appears pointed and curved in side view (Fig. 280). Spermathecae in viii, ix; two irregularly ovoid lobes of about same size and same apparent form joined by a short narrow isthmus from which the spermathecal duct originates. (Fig. 281).

Type Locality: Auckland; H. Suter, 1899.

The type material of this species has not been located.

Maoridrilus thomsoni Benham. Figs. 282, 283

1919 *Maoridrilus thomsoni* Benham, Trans. N.Z. Inst. 51:34–41.
1937 *Maoridrilus thomsoni*, Pickford, Monograph p. 91.

Benham's description was based on a single, damaged, incomplete, immature specimen, which was in a poor state of preservation. The description is therefore lacking in many necessary details, and it is very unlikely that the species would be identifiable from the description if it were collected again.

The following is a summary of Benham's description, with figures copied from Benham:

Length of fragment 65 mm. Diameter 5 mm. 198 segments.

Prostomium not developed (?).

Clitellum xvi–xx (?).

Chaetae equally spaced.

Prostatic pores on small papillae on xvii, xix, medial to line of chaeta a.

Male pores in seminal grooves, on xviii.

Spermathecal pores prominent.

Gizzard said to be in vi, but also stated that "septum v/vi is inserted at its hinder end", which would place it in v. Oesophageal glands in xiv, xv, xvi. Intestine commences in xx.

Dorsal blood vessel unpaired. Last heart in xiii.

Prostates in xvii, xix. Penial chaetae slender, curved and slightly swollen just below apex, whose sharp point is slightly bent up to form a hook; five or six faint transverse lines encircle shaft just below the swollen region (Fig. 282). Spermathecae with large ovoidal sac opening by long narrow duct; small pustulate diverticulum opens through narrow duct into spermathecal duct. (Fig. 283).

Type Locality: D'Urville Island; W. B. Benham, 1919.

Type material not located.

Remarks: D'Urville Id. is small and it is possible that, if further collecting were done on the island, specimens recognisable as *M. thomsoni* might be found. No collections from D'Urville Id. have been made during the present investigation.

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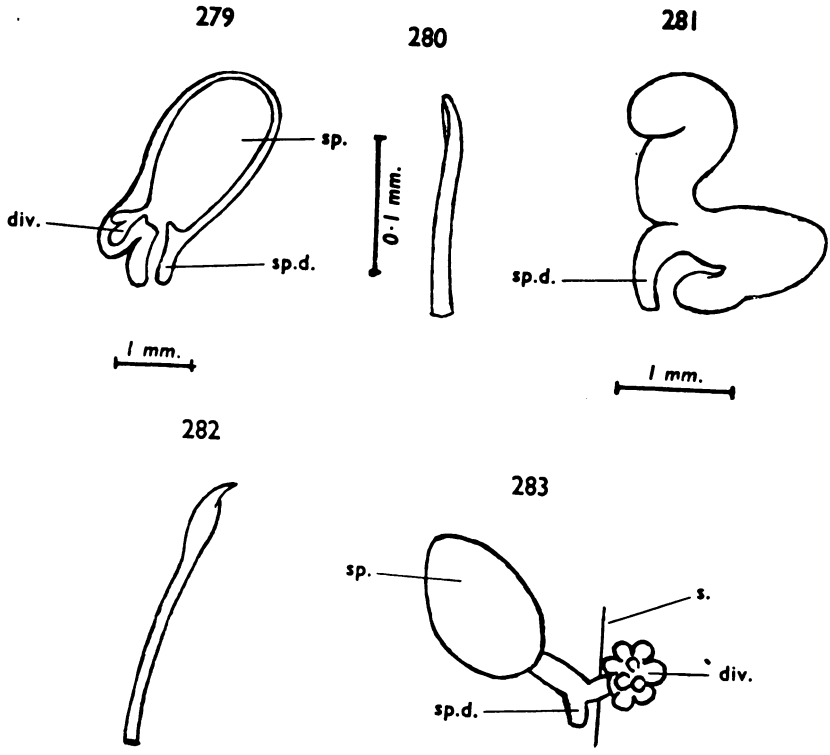

FIG. 279. *Maoridrilus intermedius.* Spermatheca. (After Michaelsen, 1923a)
FIGS. 280, 281. *Maoridrilus mauiensis*
280. Tip of penial chaeta
281. Spermatheca
(Drawings after Benham, 1904)
FIGS. 282, 283. *Maoridrilus thomsoni*
282. Tip of penial chaeta
283. Spermatheca
(Drawings after Benham, 1919)

Subfamily MEGASCOLECINAE

1900 Subfam. *Megascolecinae* Michaelsen, Tierreich 10:161.
1907 Subfam. *Megascolecinae,* Michaelsen, Fauna Südwest-Aust. 1 (2) :149.
1909 Subfam. *Megascolecinae,* Michaelsen, Mem. Indian Mus. 1:118.
1923 Subfam. *Megascolecinae,* Stephenson, Fauna Brit. India, Oligochaeta, p. 165.
1928 Fam. *Megascolecidae,* Michaelsen, Handb. Zool., Berl., 2:110.
1930 Subfam. *Megascolecinae,* Stephenson, Oligochaeta p. 828.

Forty-two New Zealand species, belonging to ten genera, have been referred to this subfamily by previous workers. Ten new species are described in this work. None of the genera is endemic to New Zealand, and all are found in Australia.

Pheretima, which is represented by only one peregrine species, is regarded as introduced by human agency.

Didymogaster, a monotypic genus otherwise known only from south-eastern Australia, is included in the New Zealand fauna on the authority

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of Ude (1893), but it is probable that there was an error in locality and it is doubtful whether the genus does occur in New Zealand.

The remaining eight genera fall into two geographic groups. One group, consisting of the genera *Megascolex* (3 spp.), *Megascolides* (23 spp.), *Notoscolex* (1 sp.) and *Spenceriella* (4 spp.), is confined to the extreme north of the North Island and neighbouring northern islands, while the other group, consisting of the genera *Diporochaeta* (10 spp.), *Perionyx* (4 spp.), *Plutellus* (3 spp.) and *Pontodrilus* (2 spp.) is confined to the southern portion of the North Island (2 spp.), Chatham Island (2 spp.), Snares Islands (1 sp.), Auckland Islands (6 spp.) and the South Island (9 spp.).

A long-standing problem in the taxonomy of Megascolecinae has been the distinction of the two genera *Megascolides* and *Notoscolex*. When the genera were first proposed they were distinguished by the form of the prostates. *Megascolides* included species with tubular prostates, in which a central canal runs through the glandular tissue and is continuous with the prostatic duct, while *Notoscolex* included species with "racemose" prostates, in which there is a branching system of canals in a more compact mass of glandular tissue and these canals discharge into the prostatic duct. The distinction broke down when it was found that the degree of branching of the canal varies and that transitional forms exist. Benham (1904b) proposed a genus, *Tokea*, for a number of New Zealand species which he considered to be intermediate between *Megascolides* and *Notoscolex*. He described the prostates of one of these species, *Tokea esculenta*, as follows:

"Each prostate is a long, tongue-shaped gland, i.e. though it is tubular in that its axis is hollow, it is not cylindrical but somewhat flattened, extending through several segments, and its apex is usually recurved. . . . The prostate is traversed by a canal lined with columnar cells; at intervals the canal receives small canalicules, around which the gland cells are grouped and into which they open. The arrangement [of cells] is similar to that described by Miss Sweet for *Plutellus intermedius* (Sweet, 1900)."

Michaelsen placed Benham's species in *Notoscolex* and Stephenson seems to have been uncertain about their position. Benham's description of the structure of the prostates of *Tokea* gives the impression that the canalicules are discrete branches of the prostatic duct. However, reference to Benham's paper (1941) on *Megascolides napierensis*, in which is figured a cross section of the prostate of *Tokea esculenta* with details of the canalicules, or to the figures in Miss Sweet's paper (1900, Pl. 15, Fig. 17), shows that the gland has a simple axial canal, but the gland cells are grouped in small clusters which discharge their secretion into a slight evagination of the axial canal. I have studied sections of the prostates of other megascolecid genera and have found arrangements of cells similar to those found by Benham in *Tokea* in acanthodriline species (e.g. *Neodrilus agilis*), which are normally regarded as having tubular prostates. The "Tokea" arrangement contrasts strongly with the branched system of ducts, with no axial canal, usually found in "racemose" prostates and closely resembles the "tubular" form both in its gross form and in the arrangement of the gland cells within

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the organ. It is better regarded as a variation of the tubular form than as a racemose prostate. Species with prostates of the "Tokea" form are therefore included in *Megascolides.*

Baird (1871) described a species, which he referred to *Megascolex*; he named it *M. antarctica,* but his description was insufficient for the recognition of the species. No locality within New Zealand was mentioned by Baird and the species has not been recorded since. It is listed in the present work as a *species incertae sedis.*

Benham (1903c) described a species, *M. laingii,* from Norfolk Island. Two species, *M. animae* and *M. novae-zealandiae,* have been recorded from the northern portion of the North Island and are included in the present work.

The remaining genera have been recorded previously from the New Zealand region. Nine new species are described and referred to these genera.

The following is a key for the identification of New Zealand Megascolecine genera:

a_1 Eight chaetae on each segment
  b_1 Purely meganephridial
    c_1 Nephridia absent in anterior segments ..... PONTODRILUS
    c_2 Nephridia present in anterior segments ..... PLUTELLUS
  b_2 Micronephridial, at least in part
    d_1 Prostates tubular, with single continuous central duct ..... MEGASCOLIDES
    d_2 Prostates racemose, with branching system of ducts
      e_1 Single gizzard, in v or vi ..... NOTOSCOLEX
      e_2 Two gizzards, one in vi and one in vii ..... DIDYMOGASTER
a_2 More than eight chaetae on each segment
  f_1 Meganephridial
    g_1 Prostate tubular, with single continuous central duct ..... DIPOROCHAETA
    g_2 Prostate racemose, with branching system of ducts ..... PERIONYX
  f_2 Micronephridial
    h_1 Gizzard in v, vi, or vii
      i_1 Prostates tubular, with single, continuous central duct ..... SPENCERIELLA
      i_2 Prostates racemose, with branching system of ducts ..... MEGASCOLEX
    h_2 Gizzard between septa vii/viii and x/xi ..... PHERETIMA

Genus DIDYMOGASTER Fletcher

1886 *Didymogaster* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 1:554.
1895 *Digaster* (part), Beddard, Monograph p. 484.
1900 *Didymogaster,* Michaelsen, Tierreich 10:199.
1930 *Didymogaster,* Stephenson, Oligochaeta p. 840.
1952 *Didymogaster,* Lee, Trans. roy. Soc. N.Z. 80:44.

Chaetae eight on each segment. Clitellum developed over (xiii)xiv–xviii, complete. Male pores one pair, on xviii, combined with prostatic pores, ventro-lateral, on papillae. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores three pairs, on ix, x, xi. Two gizzards, one in vi, one in vii. Dorsal blood vessel unpaired; four pairs of hearts in x, xi, xii, xiii. Testes two pairs, in x, xi, in testis sacs. Prostates one pair, in xviii, with branching system of ducts. Spermathecae three pairs, in vii, viii, ix, with ducts running back obliquely through body wall to ix, x, xi. Micronephridial; nephridia arranged in lateral bands on peritoneum in each segment.

Type species: *Didymogaster sylvatica* Fletcher.

Number of Species: One.

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Distribution: South-eastern Australia; a doubtful record from New Zealand (Ude, 1893).

Only one species of the genus is known. It was recorded from Australia by Fletcher (1886). He distinguished it from *Notoscolex* because it has two gizzards, one in vi and one in vii. Ude (1893) quoted a letter from Rosa, mentioning a variety of the species from New Zealand. Stephenson (1930) thought, as I do, that there may have been an error of locality. A short description of the species is included as it is possible that the species does occur in New Zealand.

Didymogaster sylvatica Fletcher. Fig. 284

1886 *Didymogaster sylvaticus* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 1:554.
1893 *Didymogaster silvaticus,* Ude, Z. wiss. Zool. 57:67.
1895 *Digaster sylvaticus,* Beddard, Monograph p. 487.
1900 *Didymogaster sylvatica,* Michaelsen, Tierreich 10:199.
1907 *Didymogaster sylvatica,* Michaelsen, Fauna Südwest-Aust. 1 (2):162.
1932 *Didymogaster sylvaticus,* Stephenson, Proc. zool. Soc. Lond., 1932 (4), pp. 919–22.
1952 *Didymogaster sylvaticus,* Lee, Trans. roy. Soc. N.Z. 80:44.

This species has not been seen during the present investigation, and the description given below is a summary of the description given by Stephenson (1932a). The figure is copied from Stephenson.

Length 89 mm. Diameter 6–8 mm. 100 segments.

Colour medium purple dorsally, paler ventrally, vivid purple clitellum.

Clitellum (xiii)xiv–xviii, complete.

Prostomium proepilobous.

Chaetae 8/segment, paired, all ventro-lateral: aa=2bc; bc>cd>ab; dd≫aa. Chaeta d is rather irregular in position.

Male pores on papillae on xviii: transverse slit-like openings with centre in line with chaeta b.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores on ix, x, xi, near middle of segment, anterior and slightly lateral to chaeta b.

Septa v/vi to vii/viii slightly thickened, viii/ix thicker, ix/x to xvi/xvii slightly thickened.

Two gizzards, in vi and vii. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi, in testis sacs. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates one pair, in xviii, of massive (racemose) type, with branched system of ducts. Prostates attached directly to parietes and duct in body wall. Spermathecae in vii, viii, ix; large

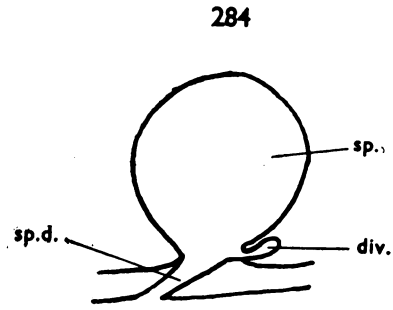

FIG. 284. *Didymogaster sylvaticus.* Spermatheca. (After Stephenson, 1932a)

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spherical sac with duct running obliquely back through body wall to pores on ix, x, xi; minute antero-lateral pyriform diverticulum at base of sac. (Fig. 284).

Micronephridial; anterior and posterior to clitellum micronephridial tubules in rows close to anterior septum of each segment, in clitellar region micronephridial tubules more numerous and widespread on peritoneum.

Type Locality: Burrawang, Springwood, Jervis Bay, N.S.W., Australia; J. J. Fletcher, 1886.

Genus DIPOROCHAETA Beddard emend. Michaelsen

1890 *Aporochaeta* (laps. cal.), *Diporochaeta* Beddard, Proc. zool. Soc. Lond., 1890, pp. 55, 56.
1895 *Diporochaeta* + *Megascolex* (part), Beddard, Monograph p. 370, 439.
1900 *Diporochaeta,* Michaelsen, Tierreich 10:199–200.
1916 *Perionyx* (part), Michaelsen, K. svenska VetenskAkad. Handl. 52:46, 53.
1923 *Perionyx* subgen. *Diporochaeta,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:229.
1923 *Diporochaeta,* Stephenson, Fauna Brit. India, Oligochaeta p. 315.
1930 *Diporochaeta,* Stephenson, Oligochaeta p. 840.
1952 *Diporochaeta,* Lee, Trans. roy. Soc. N.Z. 80:41.

Chaetae, at least in the middle and hinder parts of the body, numerous (more than eight) per segment. Clitellum developed over at least three segments between xiii and xvii; complete for all or most of its length. Male pores one pair, on xviii, combined with prostatic pores, ventro-lateral, not always on papillae. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two to five pairs, anterior to 9/10. Nephridiopores arranged in a single lateral series on each side of the body. Gizzard sometimes absent; if present, single, in v or vi. Dorsal blood vessel unpaired; two, three or four pairs of hearts, the last in xi, xii or xiii. Testes two pairs, in x, xi, or one pair, in xi, not in testis sacs. Prostates one pair, with ducts opening to the exterior in xviii; tubular. Penial chaetae and copulatory muscles usually lacking. Spermathecae two to five pairs, in segments between v and ix. Meganephridia with or without terminal vesicles.

Type species: *Diporochaeta intermedia* (Beddard).

Number of Species: About sixty, including ten from the New Zealand region.

Distribution: Australia; New Zealand, South India. Within the New Zealand region confined to western South Island, Stewart Island, subantarctic islands, Chatham Is., one species in North Island.

Diporochaeta resembles *Plutellus* in having tubular prostates and in being meganephridial, but differs from *Plutellus* in having the perichaetine arrangement of the chaetae. It resembles *Perionyx,* except that *Perionyx* has racemose prostates while *Diporochaeta* has the tubular form, i.e. *Diporochaeta* is to *Perionyx* as *Megascolides* is to *Notoscolex.* Michaelsen (1900) established the genus as at present constituted, but later (1916) combined it with *Perionyx* and still later (1923) regarded it as a subgenus of *Perionyx.* Stephenson (1923) re-constituted the

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genus as defined by Michaelsen (1900) and Stephenson's usage is adopted here.

Three new species, *D. caswelli, D. minima* and *D. punctata,* are described here, bringing the total number of New Zealand species to ten.

KEY TO THE NEW ZEALAND SPECIES OF DIPOROCHAETA

a₁ Gizzard absent
  b₁ Two (occasionally three) pairs of spermathecae
    c₁ Copulatory muscles absent ..... **D. aquatica**
    c₂ Copulatory muscles present, in xviii ..... **D. brachysoma**
  b₂ Four pairs of spermathecae ..... **D. punctata**
a₂ Gizzard present, in v
  d₁ Oesophageal glands absent ..... **D. caswelli**
  d₂ Oesophageal glands present
    e₁ Dorsal blood vessel paired ..... **D. minima**
    e₂ Dorsal blood vessel unpaired
      f₁ Testes one pair, in xi ..... **D. chathamensis**
      f₂ Testes two pairs, in x, xi ..... **D. intermedia**
a₃ Gizzard present, in vi
    g₁ Spermathecae two pairs, in viii, ix ..... **D. heterochaeta**
    g₂ Spermathecae three pairs, in vii, viii, ix
      h₁ Penial chaetae present ..... **D. duodecimalis**
      h₂ Penial chaetae absent ..... **D. obtusa**

The genus *Diporochaeta,* in the New Zealand region, is distributed on the western side of the main dividing ranges in the North and South Islands, on Stewart Island, Chatham Islands, Auckland Islands and Snares Islands (Fig. 364). One species, *D. obtusa,* extends over all these areas except for the Chatham and subantarctic islands, while the remaining nine species are restricted to small areas. *D. obtusa* is the only representative of the genus in the North Island. There is a close resemblance between many of the species, even though they are widely separated geographically.

The position and degree of development of the gizzard varies within the genus and may be used to distinguish groups of species. The gizzard, when present, is small and weakly developed, except in *D. caswelli.* Three species, *D. aquatica, D. brachysoma,* and *D. punctata* lack a gizzard; *D. caswelli, D. intermedia, D. chathamensis,* and *D. minima* have a gizzard in v; three species, *D. duodecimalis, D. heterochaeta,* and *D. obtusa,* have a gizzard in vi. Species within these groups may be further distinguished by the number and position of testes, vesiculae seminales, oesophageal glands and spermathecae (see Table 14). Such a division is convenient from the systematic viewpoint, but bears little relation to the geographical distribution of the species. The lack of any sharp distinction between widely separated species may be a reflection of the short time that has elapsed since the genus achieved its present distribution. Most of the species have probably had their present distribution patterns only since the end of the Pleistocene glacial period.

The very wide distribution of *D. obtusa* contrasts strongly with the restricted distribution of most species of the genus. *D. obtusa* closely resembles a number of other species of *Diporochaeta* (especially *D. chathamensis, D. caswelli*), anatomically and in its ecological preferences, yet unlike these species it has achieved a wide distribution in the North and South Islands. Closer investigation of the ecology of the

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TABLE 14. Diporochaeta

	aquatica	*brachysoma*
Length	38 mm.	30–35 mm.
Diameter	1·75 mm.	4 mm.
Segments	67	60–70
Colour	pink	dark purplish brown, almost black
Clitellum	xiii–xvi	xiv–xvii
Extent of clitellum	complete	complete
Prostomium	prolobous	epilobous
Chaetae, segment	c. 28	40–50
Male papillae	low, round	pores in depressions
Position of male pores ..	d e	b
Position of female pores ..	anterior to d	?
Position of spermathecal pores ..	anterior margins of (vii) viii, ix, d	7, 8, 8, 9 e
Position of nephridiopores ..	lateral	lateral
Septal thickening	absent	absent
Proventriculus	absent	absent
Gizzard	absent	absent
Nature of gizzard	..	..
Oesophageal glands	x, xi, xii	xii, xiii, xiv
1st intestinal segment ..	xvi	xvi
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	3
Last heart	xii	xii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xii botryoidal	ix, xii botryoidal
Prostates	xviii–xxiii	xviii
Penial chaetae	absent	absent
Copulatory muscles	absent	present
Position of spermathecae ..	(vii), viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	slender, pyriform	slender, pyriform
Position	lateral	lateral
Nephridial vesicles	absent	?

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TABLE 14. Diporochaeta—*continued*

caswelli	*chathamensis*	*duodecimalis*
32 mm.	50 mm.	23 mm.
2 mm.	1·5 mm.	1·75 mm.
100	c. 100	80
sienna brown	pink	purplish brown
xiv–½xvii	xiv–xvi	xiii–xvii
complete	complete	xiv-xvii complete xiii, ½xvii dorsal and lateral
epilobous	epilobous	tanylobous
8 on ii–xviii	16	12
12 posterior to xviii on narrow transverse ridge	on transverse ridge	large, flat, oval
medial to a	a	b
antero-medial to a	near ventral mid line	?
7/8, 8/9	5/6, 6/7, 7/8	6/7, 7/8, 8/9
near ventral mid line	b	b
lateral	lateral	?
absent	absent	?
absent	absent	?
v	v	vi
strong	small	very small
absent	xii, xiii, xiv, xv	?
xvii	xvii	?
unpaired	unpaired	?
3	2	?
xii	xii	?
supra-int. b.v.	dorsal b.v.	?
x, xi	xi	x, xi
ix, xii	xii	?
botryoidal	racemose	?
xviii–xxi	xviii–xxi	xviii–xxii
absent	absent	present
absent	absent	absent
viii, ix	vi, vii, viii	vii, viii, ix
1	nil	1
slender, pyriform	..	elongate
lateral	..	lateral
present	present	?

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TABLE 14. Diporochaeta—*continued*

	heterochaeta	*intermedia*
Length	65–135 mm.	64 mm.
Diameter	3 mm.	6·5 mm.
Segments	85–140	93
Colour	red brown, chaetae on white spots	dark red
Clitellum	½xiii–xvi	xiv–xvi
Extent of clitellum	complete	complete
Prostomium	epilobous	epilobous
Chaetae segment	c. 32	40–50
Male papillae	small, rounded	pores in depressions
Position of male pores	d e	c
Position of female pores	anterior to a	anterior to c
Position of spermathecal pores	posterior margins of vii, viii, d e	4/5, 5/6, 6/7, 7/8, (8/9) d
Position of nephridiopores	lateral	lateral
Septal thickening	absent	absent
Proventriculus	?	absent
Gizzard	vi	v
Nature of gizzard	very small	small
Oesophageal glands	xii, xiii, xiv, xv	x, xi
1st intestinal segment	xvii	xv
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	2
Last heart	xii	xi
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xii	ix, xii
	botryoidal	racemose
Prostates	xviii–xxviii (xxix)	xviii–xx
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Position of spermathecae	viii, ix	v, vi, vii, viii, (ix)
Spermathecal diverticula:		
Number	1	1
Form	small, pyriform	small, spheroidal
Position	lateral	medial
Nephridial vesicles	present	present

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TABLE 14. Diporochaeta—*continued*

minima	*obtusa*	*punctata*
16 mm.	21 mm.	14–18 mm.
1·25 mm.	1·5 mm.	1–1·5 mm.
57	65	67
reddish brown	reddish brown	light brown, chaetae on white spots
xiii–xvii	xiv–xvi	xiv–xvi
complete	complete	complete
tanylobous	tanylobous	epilobous
12	18	12
small, rounded	on transverse ridge	small, rounded
a/b	a/b	b
antero-medial to a	anterior to a	antero-medial to a
5/6, 6/7, 7/8, 8/9	6/7, 7/8, 8/9	5/6, 6/7, 7/8, 8/9
b	b	d
lateral	lateral	lateral
absent	absent	absent
absent	absent	absent
v	vi	absent
very small	small	..
xii–xiii (1 pair)	xiii, xiv, xv	xiii
xv	xviii	xv
paired	unpaired	unpaired
4	3	3
xiii	xii	xii
dorsal b.vv.	dorsal b.v.	dorsal b.v.
x, xi	xi	x, xi
x, xii	xii	ix, x, xi, xii
botryoidal	racemose	racemose
xviii–xx	xviii–xxiii	xviii–xx
absent	absent	absent
absent	absent	absent
vi, vii, viii, ix	vii, viii, ix	vi, vii, viii, ix
1	1	nil
long, tubular	small, globular	..
lateral	medial	..
present	present	present

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species might provide a reasonable explanation of the distribution, but until further investigations are made no explanation can be offered.

Diporochaeta aquatica Benham. Fig. 285.

1903 *Diporochaeta aquatica* Benham, Proc. zool. Soc. Lond., 1903 (2), pp. 226–8.
1904 *Diporochaeta aquatica*, Benham, Trans. N.Z. Inst. 36:192–8.
1909 *Diporochaeta aquatica*, Benham, Subant. Is. N.Z. 1:284.
1952 *Diporochaeta aquatica*, Lee, Trans. roy. Soc. N.Z. 80:41.

Length 38 mm. Diameter 1·75 mm. 67 segments.

Colour pink dorsally anterior to clitellum, clitellum grey-brown, otherwise unpigmented.

Clitellum xiii–xvi, complete.

Prostomium prolobous.

Chaetae c.28/segment; not paired, fairly evenly spaced.

Male pores on low, round papillae, in line with chaetal interval de, on xviii.

Female pores on xiv, anterior to chaeta d.

Spermathecal pores at anterior margins of viii, ix (occasionally also at anterior margin of vii), in line with chaeta d.

Nephridiopores lateral.

No specially thickened septa.

Gizzard absent. Oesophageal wall vascular and folded in x, xi, xii, but no definite glands. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi, small flat organs. Ovaries in xiii, consisting of several small lobes. Vesiculae seminales in ix, xii, botryoidal; coelomic cavity of x and xi filled with masses of loose sperms. Prostates in xviii–xxiii, tubular, openly convoluted. No penial chaetae nor copulatory muscles. Spermathecae in (vii), viii, ix; large spheroidal sac with thick duct; small, slender, pyriform diverticulum opens into lateral aspect of spermathecal duct. (Fig. 285).

Nephridia without vesicles.

Type Locality: Lake Manapouri, South Island; in water at depths of 350–500 ft.; W. B. Benham, 1903.

Type material in Otago Museum (No. A.54.92); 1 specimen, cut into five small fragments, preservation fair.

Localities:

South Island: Takahe Valley (Tunnel Burn), Te Anau; P. C. Bull, 20/2/54; 1 specimen.

Diporochaeta brachysoma Benham. Fig. 286

1909 *Diporochaeta brachysoma* Benham, Subant. Is. N.Z. 1:284–6.
1923 *Perionyx* (*Diporochaeta*) *brachysoma*, Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:232.
1950 *Diporochaeta brachysoma*, Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:31.
1952 *Perionyx brachysoma*, Lee, Trans. roy. Soc. N.Z. 80:43.

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Length 30–35 mm. Diameter 4 mm. 60–70 segments.

Colour dark purplish-brown, almost black, with orange clitellum and pale brown under surface.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae c.40–50/segment, those near dorsal surface rather more widely spaced than those near ventral mid line.

Male pores on xviii, in line with chaeta b, in a small depression.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, 8/9, in line with chaeta e.

Nephridiopores in line with 14th from ventral-most chaeta on each side.

Pharynx large and muscular. Gizzard absent. Oesophageal glands in xii, xiii, xiv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts in x, xi, xii, arising from the enteric blood plexus, with which the dorsal blood vessel is joined in xiv by four short vertical vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, small, botryoidal. Prostates tubular, confined to xviii. Copulatory muscles present. Spermathecae in viii, ix; large spherical sac with short thick duct; slender pyriform diverticulum opens into spermathecal duct. (Fig. 286).

Nephridia of small size.

Type Locality: Adams Island, Auckland Is., 2,000 ft.; under stones; W. B. Benham, 1909.

Type material in Otago Museum (No. A.07.284), 3 specimens, one cut into three pieces, well preserved.

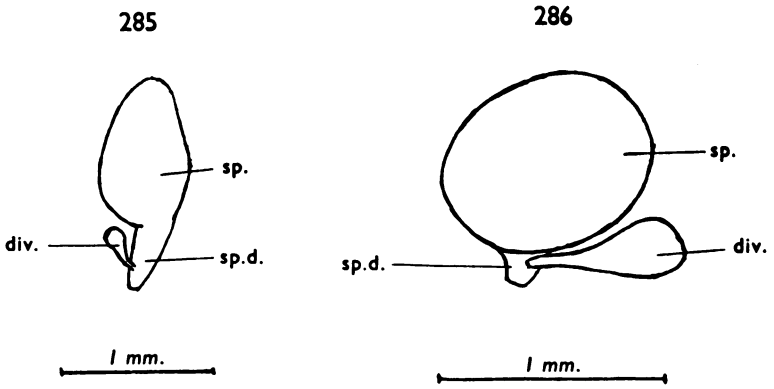

FIG. 285. *Diporochaeta aquatica.* Left spermatheca of segment viii. (After Benham, 1903d)

FIG. 286. *Diporochaeta brachysoma.* Spermatheca. (After Benham, 1909)

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Diporochaeta caswelli n.sp. Figs. 287–289

Length 32 mm. Diameter 2 mm. 100 segments.

Colour sienna brown with slightly darker brown clitellum (in alcohol).

Clitellum xiv–⅓xvii, complete.

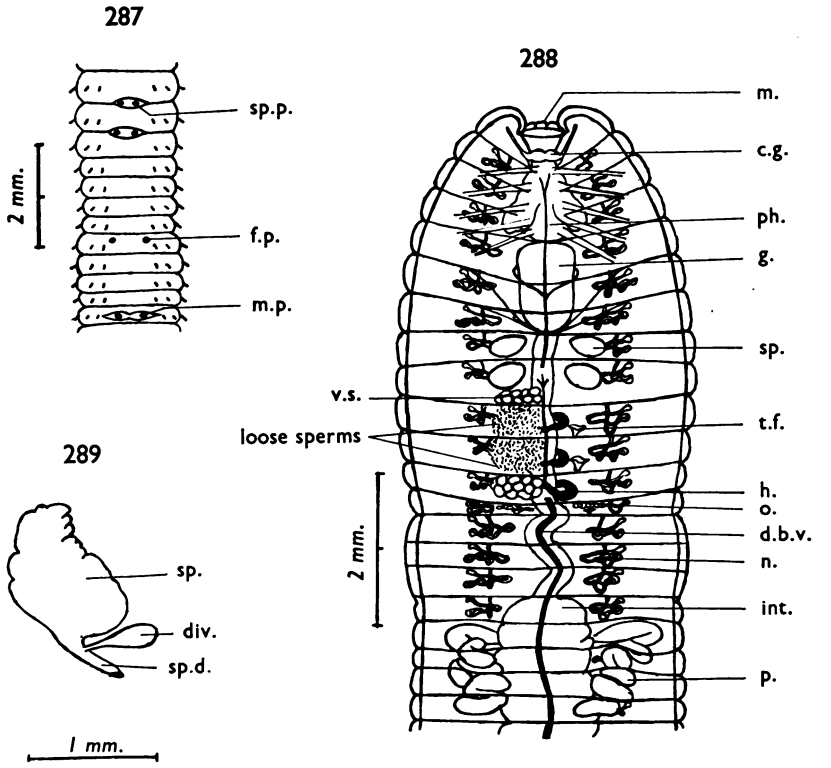
Prostomium epilobous.

Chaetae 8/segment on ii–xviii, in pairs; on xi their arrangement is: aa=bc=cd; dd=2aa; aa=2ab. Posterior to xviii the ventro-lateral pairs of chaetae (ab) are present, but the dorso-lateral pairs (cd) are replaced by groups of four chaetae, more or less evenly spaced; on xxiv their arrangement is: ab=cd=de=ef; aa=bc=ff=2ab. Male pores on a narrow transverse ridge on xviii, one on each side of the ventral mid line, medial to chaeta a. Female pores on xiv, anterior and slightly medial to chaeta a. Spermathecal pores at 7/8, 8/9, close together, adjacent to ventral mid line.

Nephridiopores in line with chaeta c.

There are no specially thickened septa.

Pharynx in i–iv; posterior portion covered dorsally and laterally by masses of small salivary glands. Gizzard in v, strongly muscular. Oesophageal glands absent. Intestine commences in xvii.



FIGS. 287–289. *Diporochaeta caswelli* n.sp.
287. Ventral aspect, segments vii–xviii
288. Dissection from dorsal aspect, segments i–xxi
289. Right posterior spermatheca anterior aspect

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Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in ix–xii. Hearts from supra-intestinal vessel in x, xi, xii.

Testicular funnels present in x, xi, but the testes could not be seen. Ovaries in xiii, laminar. Vesiculae seminales in ix, xii, botryoidal; those of ix smaller than those of xii; coelomic cavity of x, xi filled with loose masses of sperms. Prostates long, tubular, convoluted, in xviii–xxi. Neither penial chaetae nor copulatory muscles present. Spermathecae in viii, ix; large truncated conical sac with narrow duct; slender pyriform diverticulum opens into spermathecal duct. (Fig. 289).

Nephridial vesicles present.

Type Locality: Beside Stillwater R., Caswell Sound, W. Southland; under bark of rotten log; R. R. Forster, 18/4/49.

Type specimen in Canterbury Museum collection.

Localities:

South Island: Same data as type material; 13 specimens.

Diporochaeta chathamensis Benham

1901 *Diporochaeta chathamensis* Benham, Trans. N.Z. Inst. 33:134–6.
1903 *Diporochaeta chathamensis,* Benham, Proc. zool. Soc. Lond., 1903 (2), p. 204.
1907 *Diporochaeta chathamensis,* Michaelsen, Fauna Südwest-Aust. 1 (2): 161.
1952 *Diporochaeta chathamensis,* Lee, Trans. roy. Soc. N.Z. 79:537.
1952 *Diporochaeta chathamensis,* Lee, Trans. roy. Soc. N.Z. 80:41.

Length 50 mm. Diameter 1·5 mm. c.100 segments.

Colour pale pink, no pigment, clitellum yellowish (in formalin).

Clitellum xiv–xvi, complete.

Prostomium epilobous.

Chaetae 16/segment, almost evenly spaced.

Male pores on xviii in line with chaeta a, one each end of a "dumb-bell" shaped glandular ridge which extends across the segment.

Female pores on xiv, close together near anterior ventral margin.

Spermathecal pores at 5/6, 6/7, 7/8, in line with chaeta b.

Nephridiopores in line with chaeta d.

No specially thickened septa.

Gizzard in v, small. Oesophageal glands in xii, xiii, xiv, xv. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in xi, xii.

Testes in xi. Ovaries in xiii. Vesiculae seminales in xii, racemose; the coelomic cavity of xi is filled with loose sperms. Prostates in xviii–xxi, tubular, slightly coiled at end. No penial chaetae nor copulatory muscles. Spermathecae in vii, viii, ix; ovoid sac without distinct duct or diverticulum.

Small nephridial vesicles present.

Type Locality: Chatham Island; in a peat bog; W. B. Benham, 1901.

Type material in Otago Museum (No. A.56.25); a number of specimens, in very poor condition; the preservative in the tube has apparently evaporated and been replaced at some time.

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Diporochaeta duodecimalis (Michaelsen). Figs. 290, 291

1923 *Perionyx* (*Diporochaeta*) *duodecimalis* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:229–32.
1952 *Perionyx duodecimalis*, Lee, Trans. roy. Soc. N.Z. 80:43.

This species has not been seen in the present investigation, and has not been re-collected since it was originally described. The following summary is taken from the description given by Michaelsen. Figures are copied from Michaelsen.

Length 23 mm. Diameter 1·75 mm. 80 segments.

Colour purple anterior, red-brown posterior, to clitellum. Chaetae on small pale round spots.

Clitellum xiii–xvii; complete on xiv–½xvii, dorsal and lateral on xiii and posterior portion of xvii.

Prostomium tanylobous.

Chaetae 12/segment, fairly evenly spaced.

Male pores on xviii, in line with chaeta b, on large oval papillae which occupy almost the complete length of the segment.

Female pores on xiv.

Spermathecal pores at 6/7, 7/8, 8/9, ventro-lateral.

Gizzard in vi, very small. Oesophagus and intestine not mentioned. Vascular system not mentioned.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales not mentioned. Prostates in xviii–xxii, convoluted and tubular. Penial chaetae present; slender, curved, sharply pointed; spiral groove with about four turns encircling shaft near tip (Fig. 290). Spermathecae in vii, viii, ix; ovoid sac with narrow duct; single diverticulum of elongate form opening into spermathecal duct. (Fig. 291).

Meganephridia present; vesicles not mentioned.

Type Locality: Main Island, Auckland Is.; under wood and stones; W. Michaelsen, 1923.

Type specimen in University Zoological Museum, Copenhagen, Denmark.

Localities: None.

Diporochaeta heterochaeta Benham. Fig. 292

1909 *Diporochaeta heterochaeta* Benham, Subant. Is. N.Z. 1:281–3.
1923 *Perionyx* (*Diporochaeta*) *heterochaeta*, Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:232.
1952 *Perionyx heterochaeta*, Lee, Trans. roy. Soc. N.Z. 80:43.

Length 65–135 mm. Diameter 3 mm. 85–140 segments.

Colour rich red-brown, paler posteriorly and ventrally, with pale brown clitellum; chaetae arising from white spots.

Clitellum part xiii–xvi, complete.

Prostomium epilobous.

Chaetae c.32/segment; chaetae a and b of pre-clitellar segments greatly enlarged.

Male pores on xviii, in line with chaetae de, on small papillae.

Female pores on xiv, anterior to chaeta a.

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Spermathecal pores at posterior margins of vii and viii, in line with chaetal interval de.

Nephridiopores in line with chaeta g or h.

No specially thickened septa.

Very small gizzard in vi. Oesophagus dilated in xii, xiii, xiv, xv. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, large, botryoidal. Prostates in xviii–xxviii or xxix, tubular; vas deferens opens into prostate in xix, passing obliquely through gland cells. Spermathecae in viii, ix; small, irregular sac (almost spherical) with long, narrow duct; small pyriform diverticulum opens into spermathecal duct. (Fig. 292).

Nephridia have large pyriform vesicles.

Type Locality: Snares Is.; W. B. Benham, 1909.

Type (?) material in Otago Museum (No. A.07.268 B); 5 specimens and fragments, in fair condition. Two other tubes (A.07.7 with about 15 specimens and an un-numbered tube with 3 specimens) with specimens in better condition.

Diporochaeta intermedia Beddard. Fig. 293

1888 *Perichaeta intermedia* Beddard, Ann. Mag. nat. Hist., ser. 6, 2:434.
1889 *Perichaeta intermedia,* Beddard, Proc. zool. Soc. Lond., 1889, p. 380.
1890 *Perichaeta intermedia,* Beddard, Quart. J. micr. Sci. 30:467.
1890 *Perichaeta novae-zelandiae, (Diporochaeta) novae-zelandiae,* Beddard, Proc. zool. Soc. Lond., 1890, pp. 55, 56.
1890 *Perichaeta intermedia,* Benham, Quart. J. micr. Sci. 31:236.
1891 *Perichaeta intermedia,* Beddard, Proc. R. phys. Soc. Edinb. 10:276.
1893 *Perichaeta intermedia,* Smith, Trans. N.Z. Inst. 25:119, 129–32.
1895 *Diporochaeta intermedia,* Beddard, Monograph p. 439.
1900 *Diporochaeta intermedia,* Michaelsen, Tierreich 10:205.
1901 *Diporochaeta intermedia,* Benham, Trans. N.Z. Inst. 33:135.
1903 *Diporochaeta intermedia,* Benham, Proc. zool. Soc. Lond., 1903 (2), p. 204.
1906 *Diporochaeta intermedia,* Benham, Trans. N.Z. Inst. 38:255.
1907 *Diporochaeta intermedia,* Michaelsen, Fauna Südwest-Aust. 1 (2):161.
1952 *Diporochaeta intermedia,* Lee, Trans. roy. Soc. N.Z. 80:41.

Length 64 mm. Diameter 6·5 mm. 93 segments.

Colour irridescent dark red with purplish clitellum.

Clitellum xiv–xvi, complete.

Prostomium epilobous.

Chaetae 40–50/segment, evenly spaced.

Male pores in small pits on xviii, in position of chaeta c.

Female pores on xiv, anterior to chaeta c.

Spermathecal pores at 4/5, 5/6, 6/7, 7/8 (and 8/9 sometimes), ventro-lateral.

Nephridiopores lateral.

No specially thickened septa.

Gizzard in v; small. Oesophageal glands in x, xi. Intestine commences in xv.

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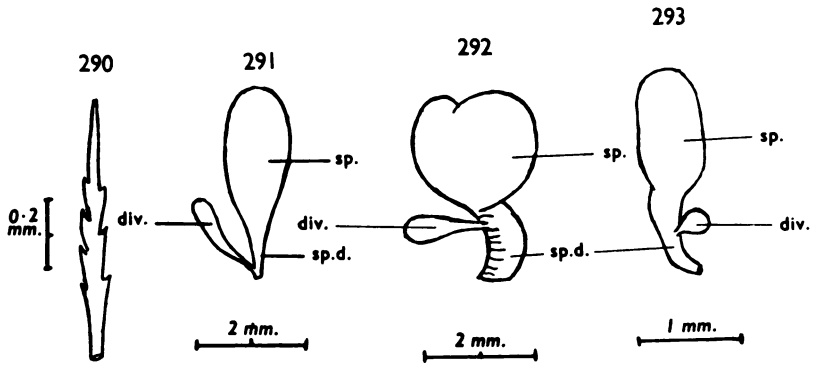

FIGS. 290, 291. *Diporochaeta duodecimalis*
290. Tip of penial chaeta
291. Spermatheca
(Drawings after Michaelsen, 1923a)
FIG. 292. *Diporochaeta heterochaeta.* Spermatheca. (After Benham, 1909)
FIG. 293. *Diporochaeta intermedia.* Spermatheca

Dorsal blood vessel unpaired. Supra-intestinal vessel commences in x. Hearts from supra-intestinal blood vessel in x, xi.

Testes in x, xi, compact. Ovaries in xiii, moniliform threads joined by thin lamina. Ovisacs in xiv. Vesiculae seminales in ix, xii, racemose; x, xi, filled with loose sperms. Prostates in xviii–xx, tubular and convoluted. Penial chaetae absent. Spermathecae in v, vi, vii, viii, (ix); cylindrical sac with long curved duct; small spheroidal diverticulum opening by very short duct into medial aspect of spermathecal duct. (Fig. 293).

Nephridia with large ovoidal vesicles.

Type Locality: Terrace of Arnold R., near Lake Brunner; leaf mould, forest; F. E. Beddard, 1888.

Type (?) specimen in British Museum (Nat. Hist.), Collection registration No. 1904.10.

Localities:

South Island: Upper Stillwater R., Caswell Sound; leaf mould, beech forest; R. R. Forster, 12/4/49; 2 specimens. Taipo Valley, Westland; leaf mould, forest; M. M. Davidson, 1951; 1 specimen.

Diporochaeta minima n.sp. Figs. 294–296

Length 16 mm. Diameter 1·25 mm. 57 segments.

Colour reddish-brown with light brown clitellum.

Clitellum xiii–xvii, complete.

Prostomium tanylobous.

Chaetae 12/segment, in pairs: ab=cd=ef; bc=de>ab; dd>aa>bc.

Male pores on xviii, on small round papillae, in line with chaetal interval ab.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, ventro-lateral.

Nephridiopores in line with chaeta c.

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Small round tuberculum pubertatis on each side of ventral mid line on ix; chaetae a and b situated on tuberculum on each side.

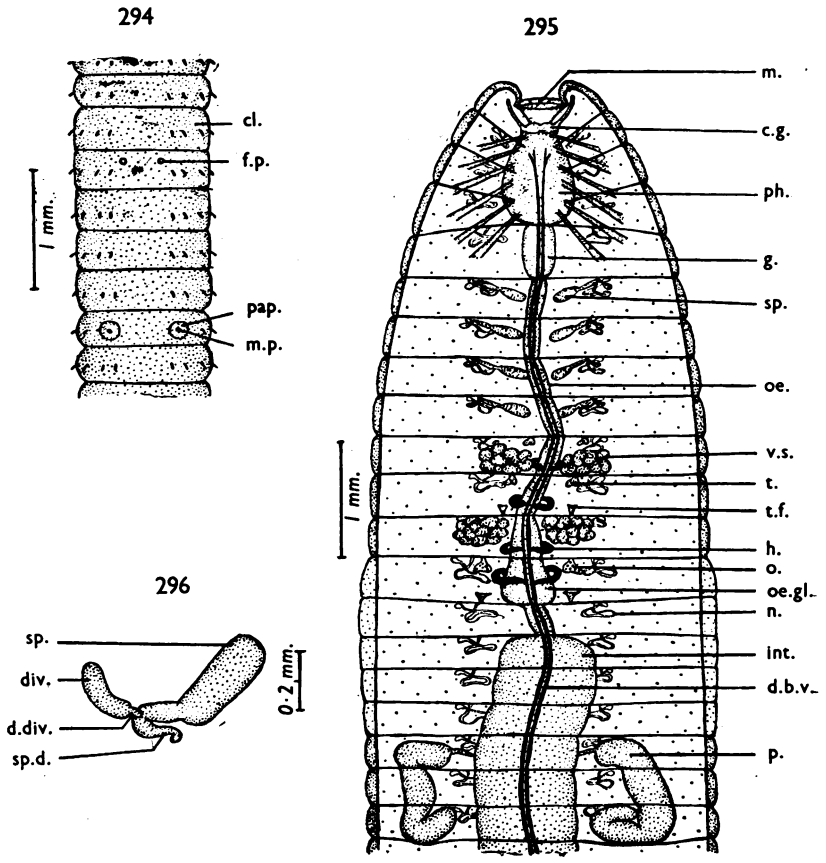
No specially thickened septa.

Small rounded pharynx in i–iv, opening into very small slender gizzard, in v. Oesophagus widely dilated to form a pyriform, thicker region in xii–xiii. Intestine commences in xv.

Dorsal blood vessel paired. Hearts from dorsal blood vessels in x, xi, xii, xiii.

Testes in x, xi; very small, bilobate. Ovaries in xiii; small, laminar. Vesiculae seminales in x, xii, botryoidal. Prostates in xviii–xx, openly convoluted and tubular. No penial chaetae nor copulatory muscles. Spermathecae in vi, vii, viii, ix; elongate tubular sac, directed medially from long, sharply recurved duct; diverticulum similar to sac, but smaller, projects laterally from small slender duct, opening into spermathecal duct at curve. (Fig. 296).

Nephridia small and slender, with small vesicles.



FIGS. 294–296. *Diporochaeta minima* n.sp.
294. Ventral aspect, segments xii–xix
295. Dissection from dorsal aspect, segments i–xx
296. Right spermatheca of viii, anterior aspect

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Type Locality: Rabbit Island, Paterson Inlet, Stewart Island; peat, beech forest; A. C. S. Wright, 12/50.

Type specimen in Soil Bureau collection.

Diporochaeta obtusa Lee. Fig. 297

1952 *Diporochaeta obtusa* Lee, Trans. roy. Soc. N.Z. 80:41–2.

Length 21 mm. Diameter 1·5 mm. 65 segments.

Colour reddish-brown with buff clitellum.

Clitellum xiv–xvi, complete.

Prostomium tanylobous.

Chaetae 18/segment, evenly spaced.

Male pores on xviii, one at each end of a "dumb-bell" shaped ridge, in line with chaetal interval ab.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaeta b.

Nephridiopores in line with chaeta e.

No specially thickened septa.

Gizzard in vi; small. Oesophageal glands in xiii, xiv, xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xii, racemose; coelomic cavity of xi filled with loose sperms. Prostates in xviii–xxiii, tubular, openly convoluted. No penial chaetae nor copulatory muscles. Spermathecae in vii, viii, ix; irregular lobed sac with long narrow duct; small round diverticulum lies medial to sac and opens by narrow duct into spermathecal duct. (Fig. 297).

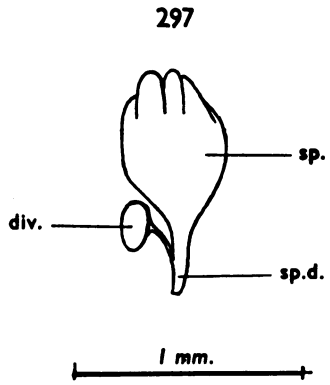

FIG. 297. *Diporochaeta obtusa.* Left posterior spermatheca, medial aspect

Nephridia with small vesicles.

Type Locality: 2 miles S. of Rotorua; leaf mould, pine forest; K.E.L., 6/10/49.

Type specimen in Soil Bureau collection.

Localities:

Northern off-shore islands: Te Waikohare Track, Little Barrier Id.; leaf mould, broadleaved forest; J. S. Edwards, 24/8/52; 1 specimen. Crater Ridge, Mayor Id.; leaf mould, scrub; J. S. Edwards, 25/11/52; 1 specimen.

North Island: Same data as type material; 2 specimens. Huia Stm., Waitakere Ra.; under stones; J. S. Edwards, 14/4/52; 2 specimens. Whatawhata, W. Waikato; leaf mould, manuka scrub; K.E.L., 18/5/50; 1 specimen. Mairoa, W. Waikato; topsoil, broadleaved forest; K.E.L., 26/5/50; 3 specimens. Motuhora; leaf mould, broadleaved forest; K.E.L., 13/1/51; 1 specimen. Chateau Tongariro; ex moss; R. R. Forster, 18/12/48; 1 specimen. Ohakune, Bligh's Track; leaf mould; T. Morle, 6/12/50: 4 specimens. Whanganui R., W. Taupo; leaf mould, scrub; A. C. S. Wright, 4/1/50; 1 specimen. Waihaha R., W. Taupo; ex moss; A. C. S. Wright, 1/51; 2 specimens. Waiouru; topsoil, podocarp forest; A. C. S.

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Wright, 25/9/50; 1 specimen. Waiouru; topsoil, tussock; K.E.L., 10/3/53; 2 specimens. Mokai Patea; litter mound of dead cedar; A. C. S. Wright, 2/51; 1 specimen. Raetihi; leaf mould, forest; R. R. Forster, 22/12/48; 6 specimens. Mt. Egmont, 2,000 ft.; leaf mould; J. S. Edwards, 11/51; 1 specimen. Mt. Egmont, 3,800 ft.; leaf mould, broadleaved forest; K.E.L., 12/5/50; 3 specimens. Dawson Falls, Mt. Egmont; under tussock; J. S. Edwards, 11/51; 1 specimen. Tahurangi, Mt. Egmont, 5,000 ft.; ex moss; J. S. Edwards, 11/51; 1 specimen. Mt. Egmont, 5,000 ft.; leaf mould and moss; T. E. Woodward, 14/11/51; 9 specimens. Hurleyville, Taranaki; leaf mould; D. E. Hurley, 10/1/50; 9 specimens. Totara Reserve, Palmerston North; leaf mould, podocarp forest; R. R. Forster, 21/8/48; 1 specimen. Foxton; topsoil, broadleaved forest; K.E.L., 12/3/52; 1 specimen. Silverstream, near Wellington; leaf mould; R. K. Dell, 20/5/50; 6 specimens. Stokes Valley, near Wellington; leaf mould; R. R. Forster, 10/8/48; 1 specimen. Taita, Hutt Valley; leaf mould, broadleaved forest; P. J. Harrigan, 12/12/52; 9 specimens.

South Island: Hillside above Nelson reservoir; leaf mould, broadleaved forest; K.E.L., 28/5/54; 4 specimens. Seddonville; leaf mould, forest; G. Southgate, 6/11/50; 3 specimens. Punakaiki; leaf mould, forest; G. Southgate, 17/1/49; 7 specimens. Blackball; leaf mould, forest; P. Hughson, 6/3/50; 4 specimens. 12 Mile, Greymouth; leaf mould, beech forest; R. R. Forster, 18/1/50; 1 specimen. Woodpecker; leaf mould, forest; R. R. Forster, 1/50; 2 specimens. Lake Mahinapua; leaf mould, podocarp forest; K.E.L., 16/1/53; 1 specimen. Taipo River; leaf mould, forest; R. Jacobs, 3/1/51; 11 specimens. Kiwi Saddle; leaf mould, forest; W. Dukes, 29/12/51; 1 specimen. Lewis Pass; leaf mould, forest; G. Southgate, 29/5/49; 3 specimens. Arthurs Pass; moss; E. Dawson, 10/1/49; 2 specimens. Wilkin Valley, L. Wanaka; leaf mould, beech forest; P. J. Harrigan, 12/52; 3 fragments. Stillwater, Caswell Sound; ex moss; R. R. Forster, 11/4/49; 8 specimens. Stillwater, Caswell Sound; under log; R. R. Forster, 12/4/49; 1 specimen. Oparara; leaf mould, forest; R. R. Forster, 20/1/50; 5 specimens.

Stewart Island: Ulva; leaf mould, beech forest; G. A. Knox, 12/1/51; 5 specimens.

Diporochaeta punctata n.sp. Figs. 298–300

Length 14–18 mm. Diameter 1–1·5 mm. 67 segments.

Colour light brown with numerous chaetae each in centre of a small raised white spot. Superficially the species is similar to *Plagiochaeta sylvestris,* with which it is sometimes found.

Clitellum xiv–xvi, complete.

Prostomium epilobous.

Chaetae 12/segment: ab=bc; aa=cd; de=ef; ff>de>aa>ab.

Male pores on xviii, on small white papillae, in position of chaeta b.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 5/6, 6/7, 7/8, 8/9, slightly medial to line of chaeta d.

Nephridiopores of ii–iv in line with chaeta e; on v and all subsequent segments in line with chaeta d.

No specially thickened septa.

Pharynx in i–iv, covered dorsally and laterally with salivary glands. Gizzard absent. Oesophagus widely dilated in xiii. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi, small, compact. Ovaries in xiii, consisting of a number of small spherical masses attached to a thin membrane. Vesiculae

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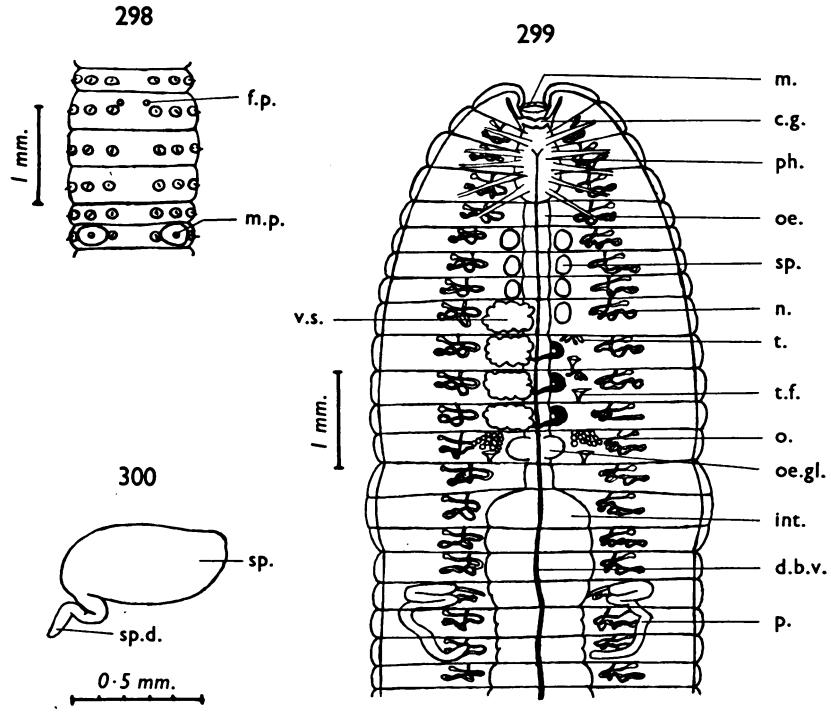

FIGS. 298–300. *Diporochaeta punctata* n.sp.
298. Ventral aspect, segments xiii–xviii
299. Dissection from dorsal aspect, segments i–xxi
300. Right posterior spermatheca, lateral aspect

seminales in ix, x, xi, xii, racemose. Prostates in xviii–xx, tubular and convoluted. No penial chaetae nor copulatory muscles. Spermathecae in vi, vii, viii, ix; dorso-ventrally flattened ovoidal sac opening through long, spirally coiled muscular duct to exterior; diverticula absent. (Fig. 300).

Nephridia with small vesicles.

Type Locality: Franz Josef; leaf mould, beech forest; R. R. Forster, 9/12/49.

Type specimen in Canterbury Museum collection.

Localities:

South Island: Same data as type material; 25 specimens. Oparara; leaf mould, forest; R. R. Forster, 20/1/50; 21 specimens. L. Sumner; leaf mould, forest; W. Dukes, 25/3/51; 13 specimens. Otira; leaf mould, forest; R. Jacobs, 26/6/50; 22 specimens. Blackball; leaf mould, forest; P. Hughson, 6/3/50; 6 specimens. Greymouth; leaf mould, forest; P. Hughson, 4/3/50; 6 specimens. Teremakau R.; leaf mould, forest; P. Hughson, 8/3/50; 4 specimens. Woodpecker; leaf mould, forest; R. R. Forster, 1/50; 2 specimens. Ferguson's Bush, near Ross; leaf mould, podocarp forest; R. R. Forster, 9/12/49; 2 specimens. Okarito; ex moss; R. R. Forster, 26/4/51; 9 specimens. L. Paringa; leaf mould, forest; P. Hughson, 23/10/50; 27 specimens. (All specimens from Canterbury Museum collections.)

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Genus MEGASCOLEX Templeton

1844 *Megascolex* Templeton, Proc. zool. Soc. Lond. 12:89.
1861 *Perichaeta* Schmarda, Neue Wirbell. Th. 1 (2):13.
1871 *Megascolex* + *Perichaeta,* Baird, Proc. Linn. Soc. 11:96.
1883 *Pleurochaeta* Beddard, Trans. roy. Soc. Edinb. 30:481.
1884 *Pleurochaeta* (? = *Megascolex* Templ.), Vejdovsky, Syst. und Morph. d. Oligoch., pp. 9, 63.
1890 *Anisochaeta* Beddard, Proc. zool. Soc. Lond., 1890, p. 56.
1894 *Mahbenus* Bourne, Quart. J. micr. Sci. 36:12.
1900 *Megascolex* (part), Michaelsen, Tierreich 10:212.
1907 *Megascolex,* Michaelsen, Mitt. zool. Mus. Hamb. 24:143–88.
1923 *Megascolex* (part), Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:234.
1930 *Megascolex,* Stephenson, Oligochaeta p. 837.
1952 *Megascolex,* Lee, Trans. roy. Soc. N.Z. 80:38.

The following is the diagnosis given by Stephenson (1930, p. 837): "Chaetae, at least in the middle and hinder parts of the body, numerous (more than eight) in each segment. Spermathecal pores usually one to five pairs (the exceptions are constituted by the few cases where they are numerous on each side in each segment). One gizzard in v, vi, or vii. Micronephridial. Prostates with branched system of ducts."

Type species: *Megascolex caeruleus* Templeton. Ceylon.

Number of Species: About one hundred and twenty, of which three, and one doubtful species listed as a *species incertae sedis,* are recorded from the New Zealand region.

Distribution: Indo-Malayan region; Australia; south-west Pacific Islands; New Zealand.

Megascolex is related to *Notoscolex,* from which it is differentiated principally by having the perichaetine arrangement of the chaetae, while *Notoscolex* has eight chaetae on each segment. It is not common in the New Zealand region, only two species (and one doubtful species) having been discovered in the North Island, and one species in Norfolk Island. (Fig. 366).

One new species, *M. animae,* is described in this work.

KEY TO THE NEW ZEALAND SPECIES OF MEGASCOLEX

a_1 Vesiculae seminales two pairs, in xi, xii; spermathecal diverticula lacking ..... **M. animae**
a_2 Vesiculae seminales two pairs, in ix, xii; spermathecae each with one diverticulum
  b_1 Last pair of hearts in xii; spermathecal diverticulum long, cylindrical, lateral ..... **M. laingii**
  b_2 Last pair of hearts in xiii; spermathecal diverticulum small, ovoidal, anterior ..... **M. novae-zealandiae**

The two species from the North Island, *M. novae-zealandiae* and *M. animae,* are closely similar in their anatomy (see Table 15) and may be regarded as closely related. The Norfolk Island species, *M. laingii,* was described from a fragment of a specimen, but such of its anatomy as was described shows that it is similar to *M. animae* in many respects. No other earthworms are known from Norfolk Island.

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TABLE 15. Megascolex

——	*animae*	*laingii*	*novae-zealandiae*
Length	196 mm.	20 mm. (fragment)	179 mm.
Diameter	13·5 mm.	2 mm.	9·5 mm.
Segments	143	28	120
Colour	dark brown (in alcohol)	purplish red with darker band round each segment	red
Clitellum	xiii–xvi	?	xiv–½xix
Extent of clitellum ..	dorsal and lateral	..	complete
Prostomium	epilobous	epilobous	epilobous
Chaetae/segment ..	20–24	16–32	c. 36
Male papillae	absent; pores in depressions	small, rounded	absent
Position of male pores ..	medial to a	b	b
Position of female pores	antero-medial to a	?	close to ventral mid line
Position of spermathecal pores	7/8, 8/9 a	7/8, 8/9 b	7/8, 8/9 ventro-lateral
Septal thickening ..	iv/v–xv/xvi	?	v/vi–xiii/xiv
Proventriculus ..	absent	absent	absent
Gizzard	v	v	v
Nature of gizzard ..	short, wide, strong	strong	long, strong
Oesophageal glands ..	absent	oesophagus dilated in xiii, xiv	absent
1st intestinal segment ..	xvi	xvi	xvi
Dorsal blood vessel ..	unpaired	unpaired	unpaired
Hearts (pairs)	3	?	4
Last heart	xii	xii	xiii
Origin of hearts ..	supra-intest, b.v.	?	dorsal b.v.
Testes	x, xi	x, xi	x, xi
Vesiculae seminales ..	xi, xii racemose	ix, xii botryoidal	ix, xii botryoidal
Prostates	xviii; flat, divided into lobes	xviii; divided into two lobes	xviii→; tongue shaped
Penial chaetae.. ..	absent	absent	absent
Copulatory muscles ..	absent	absent	absent
Spermathecae	viii, ix	viii, ix	viii, ix
Spermathecal diverticula:			
Number	absent	1	1
Form	..	long, cylindrical	small, ovoidal
Position	..	lateral	anterior
Micronephridia ..	ventro-lateral group and dorso-lateral group, attached to mesentery	lateral band	wide lateral band

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Megascolex animae n.sp. Figs. 301–304

Length 196 mm. Diameter 13·5 mm. 143 segments..

Colour dark brown dorsally, paler ventrally, with purplish clitellum (in alcohol).

Clitellum xiii–xvi, dorsal and lateral.

Prostomium epilobous.

Chaetae 20–24/segment, fairly evenly spaced though not in longitudinal lines; ventral gap about twice normal interchaetal gap and is regular.

Male pores on xviii, medial to chaeta a, one on each side of a medial ventral depression which extends over xvii–xix; pores not on papillae.

Female pores on xiv, close to ventral mid line, anterior and medial to chaeta a; transverse slit-like apertures.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Body wall very thick and muscular. Septa iv/v to xv/xvi very thick and muscular; bundles of muscle fibres arise from the posterior surfaces of these septa and pass back, sometimes through the next posterior septum, onto the body wall, where they merge with the longitudinal muscles of the body wall; there is a gradation in the thickness of these bundles of muscle fibres, those of the anterior septa being the thickest (up to 1 mm. in diameter) while those of the posterior thickened septa are slender (about 0·1 mm. in diameter). Pharynx in i–iv, wide, rounded. Gizzard in v, short, wide and strongly muscular. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii, consisting of a number of filiform processes. Vesiculae seminales in xi, xii, large, racemose. Prostates in xviii; flat, tongue-shaped organs, divided into a large number of small lobes. Spermathecae in viii, ix; large, pyriform sac opening by wide muscular duct; diverticula absent. (Fig. 303).

Nephridia of unusual form. Worm is micronephridial and there are two groups of tubules on each side of each segment, one dorso-lateral and one ventro-lateral. Individual tubules are of large size (up to 4 mm. long in dorso-lateral group) and consist of a thick, convoluted, tubular portion with long narrow duct leading in a dorsal direction, and passing through the muscle layers towards the exterior. The ducts of the dorso-lateral group lie side by side and enter the muscle layers of the body wall all together, close to the dorsal mid line, while those of the ventro-lateral group enter the muscle layers in a lateral position. There is no connection of the tubules to the septa. All the tubules on each side of the body are attached to a thin transparent mesentery which is attached to the peritoneum. A slender blood vessel passes along the base of this mesentery close to its attachment to the peritoneum (Fig. 304). Stephenson (1915a) recorded a somewhat similar arrangement of the nephridia in *M. filiciseta*, an Indian species of the genus, but in *M. filiciseta* there was apparently only one tuft on each side of each segment and the tufts were not connected to a mesentery as in the present species.

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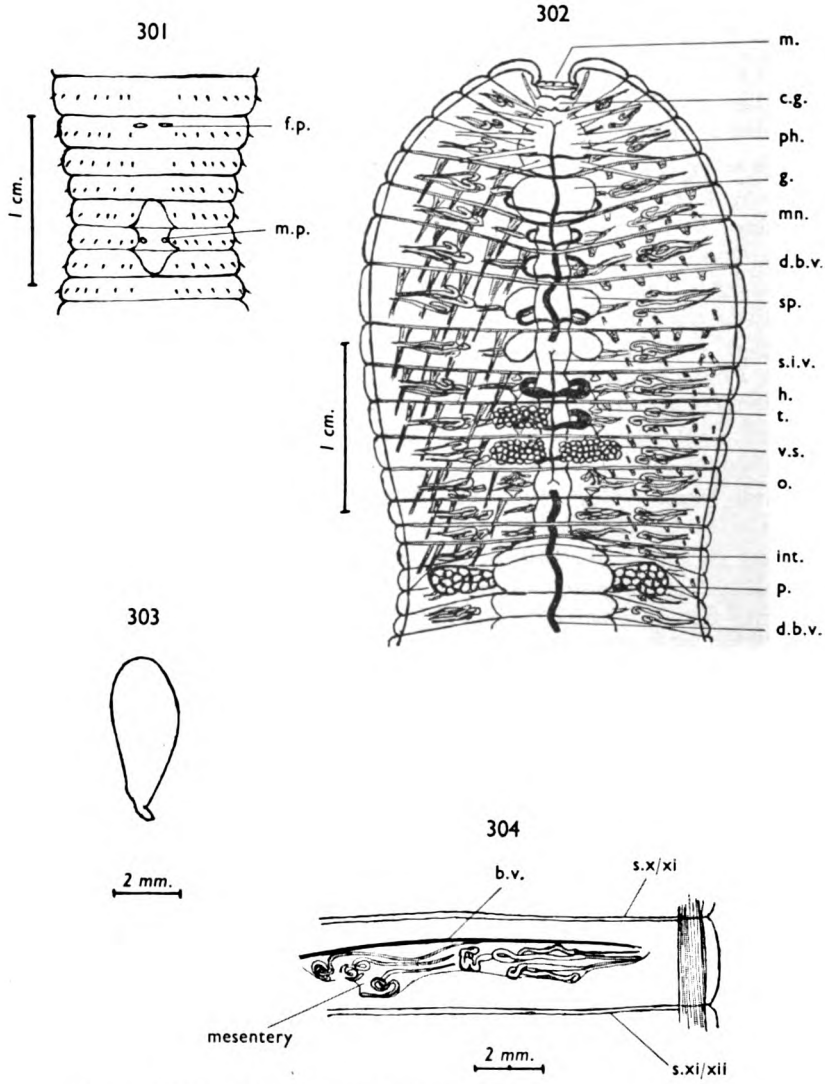
Type Locality: Unuwhao, near Spirits Bay, Northland; A. W. B. Powell, 2/46.

Type specimen in Auckland Museum collection.

Localities:

North Island: Same data as type material; 1 specimen.



FIGS. 301–304. *Megascolex animae* n.sp.
301. Ventral aspect, segments xiii–xx
302. Dissection from dorsal aspect segments i–xix
303. Right posterior spermatheca, lateral aspect
304. Arrangement of nephridia, right side of segment xi

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Megascolex laingii Benham. Fig. 305

1903 *Megascolex laingii* Benham, Trans. N.Z. Inst. 35:273–4.
1907 *Megascolex laingii*, Michaelsen, Fauna Südwest-Aust. 1 (2):163.
1952 *Megascolex laingii*, Lee, Trans. roy. Soc. N.Z. 80:38.

The species has not been seen in the present investigation. Benham's description (1903) was based on two poorly preserved anterior fragments and no further specimens have been collected. The following description and figure are taken from Benham (1903):

Length of largest fragment 20 mm. Diameter 2 mm. 28 segments.

Colour purplish red with a darker band around the middle of each segment.

Clitellum not developed.

Prostomium epilobous.

Chaetae 16–32/segment, fairly evenly spaced, except for wider dorsal and ventral gaps. (Dorsal gap wider than ventral.)

Male pores on small rounded papillae on xviii, in line with chaeta b; papillae arise from narrow longitudinal ridges, which run along xviii.

Female pores not visible.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

Gizzard in v. Oesophagus dilated slightly in xiii and xiv, but without definite glands. Intestine commences in xvi.

Dorsal blood vessel unpaired. Last heart in xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, botryoidal; coelomic cavity of x, xi, filled with loose masses of sperms. Prostates in xviii, with racemose system of ducts; each prostate divided into two (unequal) lobes. Spermathecae in viii, ix; large globular sac with short thick duct; long cylindrical diverticulum opens by short narrow duct into spermathecal duct (Fig. 305).

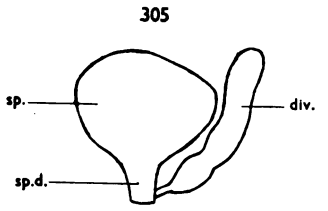

FIG. 305. *Megascolex laingii*. Spermatheca. (After Benham, 1903c)

Micronephridial; nephridia in lateral bands in each segment.

Type Locality: Norfolk Island; W. B. Benham, 1903.

Type material not located.

Localities: None.

Megascolex novae-zealandiae Lee. Fig. 306

1952 *Megascolex novae-zealandiae* Lee, Trans. roy. Soc. N.Z., 80:38–9.

Length 179 mm. Diameter 9·5 mm. 120 segments.

Colour red with darker red clitellum.

Clitellum xiv–½xix, complete.

Prostomium epilobous.

Chaetae c.36/segment, not paired, irregularly spaced.

Male pores on xviii, each pore 1·75 mm. from ventral mid line, in the centre of a small, oval, pale brown area, not on papillae.

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Female pores on xiv, very small, close to ventral mid line and to anterior margin of xiv.

Spermathecal pores not visible externally.

Septa v/vi to xiii/xiv thickened.

Gizzard in v, long and thick walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, botryoidal. Prostates originate from short duct in xviii and extend backward or forward through several segments; superficially prostates might be taken as tubular, but in sections small ducts can be seen opening into the central canal. Spermathecae in viii, ix; large pyriform sac opening through wide duct; small ovoidal diverticulum opens by short slender duct into anterior aspect of spermathecal duct. (Fig. 306). The spermathecal ducts open to the exterior at 7/8, 8/9, in ventro-lateral positions.

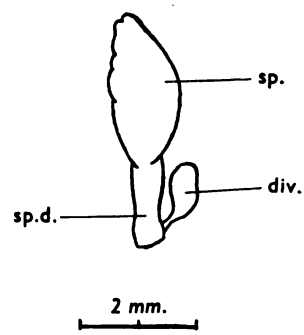

FIG. 306. *Megascolex novaezealandiae*. Right anterior spermatheca, lateral aspect

Micronephridia in a wide band on the lateral aspects of the peritoneum in each segment except the first; anterior to the gizzard the tubules are very numerous and completely cover the lateral walls of the segments.

Type Locality: Kaitaia; topsoil, broadleaved forest; K.E.L., 28/3/49. Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Mangonui; topsoil, broadleaved forest; K.E.L., 24/3/49; 3 specimens. White Cone, near Whangarei; topsoil, podocarp-broadleaved forest; K.E.L., 25/7/51; 2 specimens. Warkworth; topsoil, podocarp-broadleaved forest; K.E.L., 28/7/51; 2 specimens. Waiwera; subsoil, broadleaved forest; K.E.L., 28/7/51; 1 specimen.

Genus MEGASCOLIDES McCoy

1878 *Megascolides* McCoy, Prodr. Zool. Victoria, 1:21.
1887 *Notoscolex* (part), Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 2:603.
1889 *Lumbricus* (part), Vaillant, Hist. nat. Annel. 3 (1):113.
1895 *Cryptodrilus* (part), Beddard, Monograph p. 497.
1900 *Megascolides*, Michaelsen, Tierreich 10:182.
1904 *Tokea* (Type species: *T. esculenta* Benham) Benham, Proc. zool. Soc., London, 1904 (2), p. 240.
1907 *Megascolides*, Michaelsen, Fauna Südwest-Aust. 1 (2):153.
1916 *Megascolides* + *Notoscolex* (part), Michaelsen, K. svenska Vetensk-Akad. Handl. 52 (13).
1930 *Megascolides* + *Notoscolex* (part), Stephenson, Oligochaeta p. 835.
1952 *Megascolides*, Lee, Trans. roy. Soc. N.Z. 80:25.

Chaetae 8 per segment. Clitellum developed over at least four segments between xii and xix, usually complete. Male pores one pair, on

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xviii, combined with prostatic pores, not always on papillae. Female pores on xiv; paired, ventro-lateral, or unpaired, median ventral. Spermathecal pores one to five pairs, anterior to 9/10. Gizzard single, in v, or vi, or vii. Dorsal blood vessel usually unpaired, occasionally paired; two to five pairs of hearts, the last in xii or xiii. Testes two pairs, in x, xi, not in testis sacs. Vesiculae seminales in any or all of ix, x, xi, xii. Prostates one pair, with ducts opening to the exterior in xviii, tubular. Penial chaetae and copulatory muscles lacking in New Zealand species. Spermathecae one to five pairs, in segments between v and ix; one or two diverticula in New Zealand species, in the same segment as the sac. Micronephridia numerous in each segment; usually in lateral bands, occasionally concentrated in ventro-lateral tufts.

Type species: *Megascolides australis* McCoy. Victoria, Australia.

Number of Species: About forty-five, of which twenty-two are known from New Zealand.

Distribution: India; Australia; one species from North America (?); New Zealand. Within New Zealand confined to the north of the North Island and some northern coastal islands. (Fig. 365).

This genus is closely related to *Notoscolex,* from which it is distinguished by the morphology of the prostatic glands. The relationship between the two genera has been discussed previously (p. 259).

KEY TO THE NEW ZEALAND SPECIES OF MEGASCOLIDES

a_1 Spermathecal pores one pair, at 7/8
  b_1 Gizzard confined to v; vesiculae seminales two pairs, in xi, xii ..... **M. rubicundus**
  b_2 Gizzard confined to vi; vesiculae seminales two pairs, in ix, xii ..... **M. fuscus**
a_2 Spermathecal pores two pairs, at 7/8, 8/9, or on viii, ix
  c_1 Oesophageal glands absent
    d_1 Vesiculae seminales two pairs
      e_1 Vesiculae seminales in x, xi ..... **M. albus**
      e_2 Vesiculae seminales in ix, xii
        f_1 Micronephridial tubules arranged in band across lateral aspects of peritoneum ..... **M. neglectus**
        f_2 Micronephridial tubules arranged in a ventro-lateral tuft on each side of segments ..... **M. tasmani**
    d_2 Vesiculae seminales three pairs, in ix, xi, xii
      g_1 Female pores paired, ventro-lateral ..... **M. maoricus**
      g_2 Female pore unpaired, median ventral ..... **M. raglani**
    d_3 Vesiculae seminales four pairs, in ix, x, xi, xii ..... **M. viridis**
  c_2 Oesophageal glands one pair
    h_1 Oesophageal glands in xiii; last pair of hearts in xiii ..... **M. irregularis**
    h_2 Oesophageal glands in xiv; last pair of hearts in xii ..... **M. kirki**
  c_3 Oesophageal glands two pairs, in xii, xiii; vesiculae seminales two pairs, in xi, xii ..... **M. ruber**
  c_4 Oesophageal glands five pairs
    i_1 Oesophageal glands in ix, x, xi, xii, xiii; vesiculae seminales three pairs, in x, xi, xii ..... **M. unipapillatus**
    i_2 Oesophageal glands in x, xi, xii, xiii, xiv; vesiculae seminales four pairs, in ix, x, xi, xii ..... **M. reptans**
a_3 Spermathecal pores three pairs, at 6/7, 7/8, 8/9, or on vi, vii, viii, or vii, viii, ix
  j_1 Gizzard confined to v
    k_1 Last pair of hearts in xii
      l_1 Vesiculae seminales two pairs, in ix, xii ..... **M. parvus**
      l_2 Vesiculae seminales two pairs, in x, xi ..... **M. huttoni**
      l_3 Vesiculae seminales four pairs, in ix, x, xi, xii ..... **M. urewerae**
    k_2 Last pair of hearts in xiii
      m_1 Gizzard large and strong ..... **M. sapidus**

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m_2 Gizzard small, not well developed
n_1 Spermathecae with elongate tubular sac and slender, pyriform, medial diverticulum ..... **M. mortenseni**
n_2 Spermathecae with stout ovoidal sac and short, pyriform, medial diverticulum ..... **M. esculentus**
j_2 Gizzard confined to vi
o_1 Last pair of hearts in xii ..... **M. suteri**
o_2 Last pair of hearts in xiii ..... **M. equestris**
a_1 Spermathecal pores, four pairs, on vi, vii, viii, ix ..... **M. napierensis**

Twenty-two New Zealand species are assigned to the genus *Megascolides*. *M. mortenseni* and *M. napierensis* have each been collected only once, the former from a suburban garden at Palmerston North and the latter from a nurseryman's glasshouse at Napier. Both of these localities are separated from the range of all the other recorded species of the genus by the extensive "ash shower" country of the central North Island, which has apparently been a barrier to the dispersal of the genus, and were found in cultivated ground, while all the other New Zealand species have been found only in soils under native vegetation. The two species have almost certainly been introduced by man.

Two new species, *M. rubicundus* and *M. tasmani,* are described in the present work.

Apart from the two species considered as probably introduced, the genus is continuously distributed from the Three Kings Islands in the north (34° S. lat.) to a line about 37° 30′ S. lat. in the central districts of the North Island (Fig. 365). The southern limit of the genus seems to be defined by the northern limit of recent large volcanic ash showers. The soils formed from one of these showers (the Taupo shower) have a coarse physical structure and tend to dry out badly in the hot summer months. The vegetation on large areas covered by this shower is characteristic of the drier, eastern parts of the country, although the climate is suitable for rain forest. The New Zealand species of *Megascolides* inhabit rain forest almost exclusively, and are found in leaf mould, topsoil, and subsoil. The absence of continuous forested areas in much of the ash shower country, combined with the unfavourable soil conditions, have probably brought about the sharply defined southern limit of the genus. One species, *M. suteri,* is found occasionally within the boundaries of the Taupo ash shower. However, this species lives in rotten logs, not in the soil, and consequently is not affected by the soil conditions. Where the coarse pumice soils of the Taupo ash have been extensively modified, e.g. by the deposition of Rotomahana mud over the Taupo ash in the Rotorua district, species have spread further south. In the east, *Megascolides* has advanced around the coast of the Bay of Plenty to East Cape, and up river valleys and through gorges in the mountainous inland area near East Cape. The genus has not become established on the east coast south of East Cape. On the western side of the North Island, one species, *M. raglani,* is found in Waikato, but none is found further south. The main centre of the genus in New Zealand is in the North Auckland peninsula and the islands north and east of the peninsula. It is probable that the genus, together with *Megascolex, Spenceriella,* and *Notoscolex* (the last genus may have been introduced by man), entered New Zealand from the north in fairly recent times, and has not been here for sufficient time

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to have migrated into and established itself in the region now covered by the Taupo ash showers.

No attempt will be made to divide the species into groups of related species. They are all distributed within a small area and are all closely related in their anatomy (see Table 16), and no significant groups of species can be distinguished.

Megascolides albus Lee. Fig. 307

1952 *Megascolides alba* Lee, Trans. roy. Soc. N.Z. 80:35–6.

Length 90 mm. Diameter 7·5 mm. 141 segments.

Body completely unpigmented except for a pale yellowish clitellum. The prostates are visible through the transparent body wall, lying close to ventral nerve cord.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: aa>bc>ab>cd; dd≫aa.

Male pores on xviii, each in the centre of a small, white, oval area, in line with chaetal interval ab.

Female pores on xiv, slightly medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa v/vi to xi/xii thickened.

Gizzard in v. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in ix, x, xi, xii, xiii, those of ix smaller than those of x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, racemose. Prostates extending through xviii–xxvii (sometimes xviii–xxix), ventral to intestine, one on each side, beside the ventral nerve cord. Spermathecae in viii, ix; large irregular, sub-spherical sac opening through long wide duct; small pyriform diverticulum without definite duct opens into medial aspect of spermathecal duct. (Fig. 307).

Micronephridia in narrow band across lateral aspects of body wall in each segment except i.

Type Locality: Maungakaramea, Northland; subsoil, broadleaved forest; K.E.L., 17/1/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 3 specimens.

Megascolides equestris (Benham). Fig. 308

1942 *Notoscolex equestris* Benham, Trans. roy. Soc. N.Z. 72:220–5.
1949 *Notoscolex equestris,* Benham, Trans. roy. Soc. N.Z. 77:348.
1950 *Notoscolex equestris,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:33.
1952 *Notoscolex equestris,* Lee, Trans. roy. Soc. N.Z. 80:37.

Benham placed this species in the genus *Notoscolex,* following the practice of Michaelsen, because the prostates are long, narrow, tongue

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TABLE 16. Megascolides

——	*albus*	*equestris*
Length	90 mm.	210 mm.
Diameter	7·5 mm.	10–16 mm.
Segments	141	c. 150
Colour	unpigmented	alternating bands of brown and cream; white papilla round chaetae c and d
Clitellum	xiv–xvii	xiv–xvii
Extent of clitellum	complete	complete
Prostomium	epilobous	epilobous
Male papillae	absent	one each side of mid-ventral depression
Position of male pores	a/b	a
Position of female pores	medial to a	close to ventral mid line
Position of spermathecal pores	7/8, 8/9 a	anterior margins of vii, viii, ix
Septal thickening	v/vi–xi/xii	vi/vii–xii/xiii
Proventriculus	absent	v
Gizzard	v	vi
Nature of gizzard	strong	strong
Oesophageal glands	absent	absent
1st intestinal segment	xvii	xvii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	5	4
Last heart	xiii	xiii
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	x, xi	ix, xii
	racemose	sac
Prostates	xviii–xxviii	xviii–xxii
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	viii, ix	vii, viii, ix
Spermathecal diverticula:		
Number	1	2
Form	small, pyriform	low, rounded excrescences on duct
Position	medial	lateral
Micronephridial tubules	narrow lateral band	dense mat on peritoneum

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TABLE 16. Megascolides—*continued*

esculentus	*fuscus*	*huttoni*	*irregularis*
100 mm.	251 mm.	80 mm.	117 mm.
6 mm.	10 mm.	5 mm.	7·5–8 mm.
110	268	63	120
purplish red	brown	purplish	purplish red
xiv–xvii	xiv–xviii	xiii–xviii	xiv–xvii
complete	xv–xvi complete elsewhere dorsal and lateral	xiv–xvii complete, elsewhere dorsal	complete
epilobous	epilobous	epilobous	epilobous
small, in shallow pits	prominent, rounded	absent	absent; pore surrounded by ridge
a	a	a/b	a
close to ventral mid line	antero-lateral to a	antero-medial to a	close to ventral mid line
posterior margins of vi, vii, viii a	7/8 b	posterior on vi, vii, viii a/b	7/8, 8/9 a
vii/viii–xiv/xv	vii/viii–xi/xii	vii/viii–xiii/xiv	v/vi–xi/xii
absent	v	absent	absent
v	vi	v	v
small	strong	long, narrow	small
xv	absent	absent	xiii
xvi	xvii	xvi	xvi
unpaired	unpaired	unpaired	unpaired
4	4	3	4
xiii	xiii	xii	xiii
dorsal and supra-intest. b. vv.	supra-intest. b.v.	dorsal b.v.	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
ix, xii sac	xi, xii racemose	x, xi racemose	ix, xii racemose
xviii→	xviii–xx	xviii–xvi	xviii–xx (xxi)
absent	absent	absent	absent
absent	absent	absent	absent
vii, viii, ix	viii	vii, viii, ix	viii, ix
1	1	1	1
short, pyriform	small, tubular	slender, pyriform	small, spheroidal
medial lateral band; nephridial funnels in all segments	anterior ventro-lateral tufts	medial broad lateral band	medial narrow lateral band

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TABLE 16. Megascolides—*continued*

——	*kirki*	*maoricus*
Length	80–100 mm.	70 mm.
Diameter	6 mm.	4 mm.
Segments	110	75
Colour	reddish purple	dark purplish brown
Clitellum	xiii–xvii	xiii–xvii
Extent of clitellum	dorsal and lateral	complete
Prostomium	tanylobous	epilobous
Male papillae	large, flat	large, flat, oval
Position of male pores ..	b	a
Position of female pores ..	close to ventral mid line	antero-medial to a
Position of spermathecal pores ..	7/8, 8/9 b	posterior on viii, ix, a
Septal thickening	absent	absent
Proventriculus	v	absent
Gizzard	v ?	v
Nature of gizzard	small	small
Oesophageal glands	xiv	absent
1st intestinal segment ..	?	xvi
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	3
Last heart	xii	xii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	xi, xii racemose	ix, xi, xii racemose
Prostates	xviii–xxiii	xviii→
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	small, pyriform	very small, pyriform
Position	antero-medial	medial
Micronephridial tubules ..	narrow lateral band	broad lateral band

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TABLE 16. Megascolides—*continued*

mortenseni	*napierensis*	*neglectus*	*parvus*
46 mm. (fragment)	550 mm.	75 mm	26·5 mm.
4·5–5 mm.	10 mm.	3–4 mm.	3·5 mm.
82	?	104	72
reddish grey to brown	chocolate brown	brownish yellow	reddish brown
xiii–xviii	½xii–xviii	xiii–xviii	xiv–xviii
xiii–xvii complete	complete	xiii–xvii complete	complete
xviii dorsal and lateral		xviii dorsal and lateral	
epilobous	epilobous	epilobous	epilobous
small, oval, flat	low, rounded	prominent, rounded	low, rounded
medial to a	b	a	a
?	antero-medial to a	?	near ventral mid line
6/7, 7/8, 8/9 a	vi, vii, viii, ix, b/c	7/8, 8/9 a	6/7, 7/8, 8/9 medial to a
ix/x–xii/xiii	ix/x–xi/xii	ix/x–xiii/xiv	vii/viii–xii/xiii
absent	v–vi	?	absent
v	vii	vi	v
small	small	strong	strong
?	absent	absent	xii
xvi	xvii	xvi	xv
?	unpaired	?	unpaired
?	2	4	3
xiii	xiii	xii	xii
?	dorsal b.v. and supra-intest. plexus	?	dorsal b.v.
x, xi	x, xi	x, xi	x, xi
ix, xii	ix, xii	ix, xii	ix, xii
sac	sac	?	racemose
xviii	xviii	xviii–xxiii	xviii–xxiii
absent	absent	absent	absent
absent	absent	absent	absent
vii, viii, ix	vi, vii, viii, ix	viii, ix	vii, viii, ix
1	1	1	1
slender, pyriform	small, sub-spherical	small, spheroidal	small, spherical
medial	lateral	lateral	posterior
lateral band	narrow lateral band	lateral band	broad lateral band

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TABLE 16. Megascolides—*continued*

——	*raglani*	*replans*
Length	81 mm.	100 mm.
Diameter	5 mm.	5 mm.
Segments	101	100
Colour	brick red	brick red
Clitellum	xiii–xviii	xiv–xvii
Extent of clitellum	complete	complete
Prostomium	epilobous	epilobous
Male papillae	absent; small oval depression round each pore	small, rounded
Position of male pores	a	a
Position of female pores	unpaired, anterior, mid ventral	..
Position of spermathecal pores	7/8, 8/9 a/b	7/8, 8/9 a
Septal thickening	ix/x–xiii/xiv	vii/viii–xiv/xv
Proventriculus	absent	v
Gizzard	v	vi
Nature of gizzard	large, strong	strong
Oesophageal glands	absent	x, xi, xii, xiii, xiv
1st intestinal segment	xvi	xvi
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	4	3
Last heart	xii	xii
Origin of hearts	dorsal b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xi, xii sac	ix, x, xi, xii racemose
Prostates	xviii–xix	xviii–xxiii
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	elongate, pyriform	small, slender, pyriform
Position	medial	?
Micronephridial tubules	narrow lateral band	lateral band

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TABLE 16. Megascolides—*continued*

ruber	*rubicundus*	*sapidus*
70–80 mm.	114 mm.	200 mm.
4–5 mm.	4·5 mm.	8 mm.
80	97	190
dark red	purplish red	dark brown
xiv–xviii	xiv–xxviii	(xiii) xiv–xviii (xix)
complete	xiv–xvii complete xviii–xxviii dors. and lateral	xiv–xvii complete xviii dors. and lateral
epilobous	epilobous	prolobous
absent; pores in small depressions	absent; pores in small depressions	absent; pores on edges of medial depression
a/b	a	medial to b
unpaired; anterior, median ventral	near ventral mid line	anterior to b
7/8, 8/9 b	7/8 a	6/7, 7/8, 8/9 a/b
absent	absent	vi/vii–xiii/xiv
absent	part v	absent
v	part v	v
small	strong	strong
xii, xiii	absent	absent
xvi	xv	xvi
unpaired	unpaired	unpaired
3	4	4
xii	xiii	xiii
dorsal b.v.	dorsal b.v.	d.b.v. and supra-intest. v.
x, xi	x, xi	x, xi
xi, xii	xi, xii	ix, xii
racemose	racemose	sac
xviii–xx (xxi)	xviii–xxii	xviii–xxvi
absent	absent	absent
absent	absent	absent
viii, ix	viii	vii, viii, ix
1	1	1
very small, pyriform	small, slender, pyriform	small, globular
anterior	medial	posterior
narrow lateral band	broad lateral band	broad lateral band

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TABLE 16. Megascolides—*continued*

	suteri	*tasmani*
Length	50 mm.	67·5 mm.
Diameter	5 mm.	6 mm.
Segments	86	132
Colour	purplish red	purplish red
Clitellum	xiii–xvii	xiii–xviii
Extent of clitellum	complete	dorsal and lateral
Prostomium	epilobous	epilobous
Male papillae	small, rounded	small, oval, flat
Position of male pores	a	a
Position of female pores	antero-medial to a	antero-medial to a
Position of spermathecal pores	6/7, 7/8, 8/9 a	7/8, 8/9 a
Septal thickening	viii/ix–xii/xiii	viii/ix–xiii/xiv
Proventriculus	v	absent
Gizzard	vi	v
Nature of gizzard	feeble	very small
Oesophageal glands	slightly dilated in xii	absent
1st intestinal segment	xvi	xvi
Dorsal blood vessel	unpaired	paired x/xi–xv/xvi, fusing at septa
Hearts (pairs)	3	3
Last heart	xii	xii
Origin of hearts	supra-intest. b.v.	supra-intest. b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xii	ix, xii
	racemose	racemose
Prostates	xviii–xxiii	xviii–xx
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	vii, viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	slender, pyriform	small, pyriform
Position	medial	medial
Micronephridial tubules	broad lateral band	ventro-lateral tufts

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TABLE 16. Megascolides—*continued*

unipapillatus	*urewerae*	*viridis*
40 mm.	65–80 mm.	54 mm.
3 mm.	7–8 mm.	4·5 mm.
80	78	66
colourless	pale brownish	reddish brown dorsally bluish green ventrally
xiv–xvii	xiv–xvii	xiv–xvii
complete	complete	complete
epilobous	epilobous	epilobous
absent; pores on edges of median ventral depression a	absent; pores in small round depressions a	small, round lateral to a
anterior to a	anterior to a	antero-medial to a
7/8, 8/9 a	posterior on vi, vii, viii. a	7/8, 8/9 a
viii/ix–xiv/xv	vi/vii–xii/xiii	vii/viii–xiii/xiv
absent	absent	absent
v	v	v
strong	long, narrow	slender; thick walls
ix, x, xi, xii, xiii	xi, xii, xiii, xiv, xv	absent
xvi	xvi	xv
unpaired	unpaired	unpaired
3	3	3
xii	xii	xii
supra-intest. b.v.	dorsal b.v.	supra-intest. b.v.
x, xi	x, xi	x, xi
x, xi, xii	ix, x, xi, xii	ix, x, xi, xii
racemose	racemose	racemose
xviii–xvi	xviii–xxvi	xviii→
absent	absent	absent
absent	absent	absent
viii, ix	vii, viii, ix	viii, ix
1	1	1
small, pyriform	slender, pyriform	slender, pyriform
?	posterior	medial
broad lateral band	lateral band	broad lateral band

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shaped, with a rough surface, and the margins are somewhat indented at intervals. I have examined the type specimens and specimens of the species from the type locality, and dissected the prostatic glands to determine whether the duct branches within the gland. The glands appear to have the same structure as those of species formerly included in Benham's *Tokea*, so I have placed the species in *Megascolides*.

Length 210 mm. Diameter 10–16 mm. c.150 segments.

Colour—alternating bands of chocolate brown and pale cream (intersegmental) dorsally, pale ventrally, with dark brown clitellum; small white papillae around chaetae c and d on each segment.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: aa=4 mm.; ab=3 mm.; chaetae c and d are not arranged in regular rows, but vary in position (especially chaeta d) from segment to segment.

Male pores on xviii, one on each side of a narrow transverse depression surrounded by a ridge, in line with chaeta a.

Female pores on xiv, one each side of a very small, median ventral, transverse depression, close to ventral mid line.

Spermathecal pores at anterior margins of vii, viii, ix, ventro-lateral.

Septa vi/vii to xii/xiii thickened.

Gizzard in vi. Oesophageal glands absent. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xviii–xxii, long, narrow, tongue shaped, with a rough surface, the margins somewhat indented at intervals. Large oval glandular thickened areas lie across the ventral mid line in xvii and xix, and correspond to external oval tubercula pubertatis on these segments. Spermathecae in vii, viii, ix; large ovate sac with long duct; no obvious diverticula, but the duct has two low, rounded excrescences on one side, which may represent diverticula. (Fig. 308).

Micronephridia in a dense mat of small slender tubules on the peritoneum.

Type Locality: Tawhiti Rahi, Poor Knights Is.; W. B. Benham, 1942.

Type material in Otago Museum (No. A.43.52); 2 specimens, in fair condition.

Localities:

Poor Knights Islands: Tawhiti Rahi; G. A. Buddle and R. A. Wilson; 4 specimens. (Auckland Museum collection).

Megascolides esculentus (Benham). Fig. 309

1904 *Tokea esculenta* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 242–5.
1905 *Tokea esculenta*, Benham, Trans. N.Z. Inst. 37:283.
1907 *Megascolides esculenta*, Michaelsen, Fauna Südwest-Aust. 1 (2):161.
1916 *Notoscolex esculenta*, Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1941 *Megascolides (Tokea) esculenta*, Benham, Trans. roy. Soc. N.Z. 71:27.
1952 *Megascolides esculenta*, Lee, Trans. roy. Soc. N.Z. 80:27.

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Length 100 mm. Diameter 6 mm. 110 segments.

Colour purplish red, with brown clitellum.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd=2aa.

Male pores on xviii, in line with chaeta a, each on a small papilla, arising from a small pit.

Female pores on xiv, close to ventral mid line, near anterior margin of segment.

Spermathecal pores on vi, vii, viii, midway between chaeta a and posterior margin of segment.

Septa vii/viii to xiv/xv thickened.

Gizzard in v, small. Oesophagus dilated in xv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in x–xiii. Hearts in x, xi, xii, xiii, connected to dorsal and supra-intestinal vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, sac-like. Prostates long and tubular, arising in xviii and varying in extent; ventral to intestine. Spermathecae in vii, viii, ix; ovoidal sac with short wide duct; short, pyriform diverticulum opening through duct into medial aspect of spermathecal duct. (Fig. 309).

Micronephridia commence in iii; in last 20 segments is a pair of compact groups of tubules, nephridial funnels present in these segments—can be traced to tubule which opens to exterior in vicinity of chaeta a—funnels are present in all other segments, but have no connection with nephridia.

Type Locality: Ruatahuna, Central North Island; W. B. Benham, 1904.

Type material in Otago Museum (No. A.04.96); 2 specimens and fragments, in good condition.

Megascolides fuscus Lee. Fig. 310

1952 *Megascolides fuscus* Lee, Trans. roy. Soc. N.Z. 80:32–4.

Length 251 mm. Diameter 10 mm. 268 segments; ii–vi biannulate, vii–xviii quadriannulate and the post-clitellar segments biannulate.

Colour brown, with greyish brown clitellum.

Clitellum xiv–xviii, complete on xv and xvi, otherwise dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: aa=bc>cd>ab; dd ≫ aa.

Male pores on prominent rounded papillae on xviii, in position of chaeta a.

Female pores on xiv, slightly anterior and lateral to chaeta a.

Spermathecal pores at 7/8, in line with chaeta b.

The first septum is at iv/v. Septa vii/viii to xi/xii thickened.

Proventriculus in v, short, wide, thin walled. Gizzard in vi, stout and muscular. Oesophageal glands absent. Intestine commences in xvii.

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Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii. Testes in x, xi, small, bilobed; very prominent vasa deferentia remain distinct back to xviii, where they fuse just before entering the prostatic ducts. Ovaries in xiii, much larger than testes, thin, lace-like laminar structures. Vesiculae seminales in xi, xii, racemose. Prostates in xviii–xx, tubular, convoluted, lateral to intestine. Spermathecae in viii; large, thin-walled ovoidal sac with long narrow duct; small tubular diverticulum opens into anterior aspect of spermathecal duct. (Fig. 310).

Micronephridia in a compact ventro-lateral cluster on each side of each segment except i; individual tubules very long and twisted in the form of a corkscrew.

Type Locality: 9 miles E. of Rotorua; subsoil, broadleaved forest; K.E.L., 6/10/49. Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 4 specimens. Hamurana Springs; topsoil, broadleaved forest; K.E.L., 4/10/49; 2 specimens. Kaingaroa Forest, Waiotapu; topsoil, pine forest; K.E.L., 6/10/49; 2 specimens.

Megascolides huttoni (Benham)

1904 *Tokea huttoni* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 248–50.
1905 *Tokea huttoni,* Benham, Trans. N.Z. Inst. 37:283.
1907 *Megascolides huttoni,* Michaelsen, Fauna Südwest-Aust. 1 (2).
1916 *Notoscolex huttoni,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1952 *Megascolides huttoni,* Lee, Trans. roy. Soc. N.Z. 80:27.

M. huttoni has not been re-collected during the present investigation. Benham's original description was incomplete and the following description is based on information derived from a re-examination of the type material.

Length 80 mm. Diameter 5 mm. 63 segments.

Colour purplish.

Clitellum xiii–xviii; complete on xiv to xvii, dorsal only on xiii and xviii.

Prostomium epilobous.

Chaetae 8/segment: aa=bc=cd>ab; dd>aa.

Male pores on xviii, in line with chaetal interval ab, not on papillae but on edges of median ventral circular depression.

Female pores on xiv, close to ventral mid line, antero-medial to chaeta a.

Spermathecal pores at hinder margins of vi, vii, viii, in line with chaetal interval ab.

Septa vii/viii to xiii/xiv thickened.

Gizzard in v, long, narrow, thin walled. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts in x, xi, xii, arising from dorsal blood vessel.

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Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, racemose. Prostates in xviii–xvi, tubular, lying beneath intestine. Spermathecae in vii, viii, ix; duct short, diverticulum slender, pyriform, with narrow duct opening into medial aspect of spermathecal duct. Micronephridial tubules in broad bands on the lateral aspects of the peritoneum.

Type Locality: Whangarei; W. B. Benham, 1904.

Type material in Otago Museum (No. A.02.139); 5 specimens, 1 adult, 4 juvenile, in good condition.

Megascolides irregularis Lee. Fig. 311

1952 *Megascolides irregularis* Lee, Trans. roy. Soc. N.Z. 80:34–5.

Length 117 mm. Diameter 7·5–8 mm. 120 segments.

Colour purplish red dorsally, pale ventrally, with buff clitellum.

Clitellum xiv–xvii, complete except for a small area on xiv surrounding the female pores.

Prostomium epilobous.

Chaetae 8/segment, not in pairs: the distance aa is regular anterior to the male pores, but the remainder of the chaetal intervals are irregular and the eight chaetae of each segment are scattered indiscriminately, four on each side of each segment. In this respect the species shows some resemblance to *M. equestris,* but it differs from that species in other respects (see Table 16).

Male pores on xviii, in line with chaeta a, not on papillae, but each pore surrounded by a horseshoe-shaped ridge with the open end facing the ventral mid line.

Female pores on xiv, close to ventral mid line in a small pale area at the anterior margin of the segment.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa v/vi to xi/xii thickened.

Gizzard in v, small. Oesophageal glands in xiii. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xviii–xx (or xxi), ventral to intestine, one on each side of the ventral nerve cord. Spermathecae in viii, ix; slender, truncated ovoidal sac opening through long wide duct; small spheroidal diverticulum opens by very short duct into medial aspect of spermathecal duct. (Fig. 311).

Micronephridia in narrow band across lateral and dorso-lateral aspects of each segment except i; in i there is a compact cluster of tubules larger than the normal micronephridia, lateral in position.

Type Locality: Tangowahine, Northland; topsoil, broadleaved forest; K.E.L., 15/1/49.

Type specimen in Soil Bureau collection.

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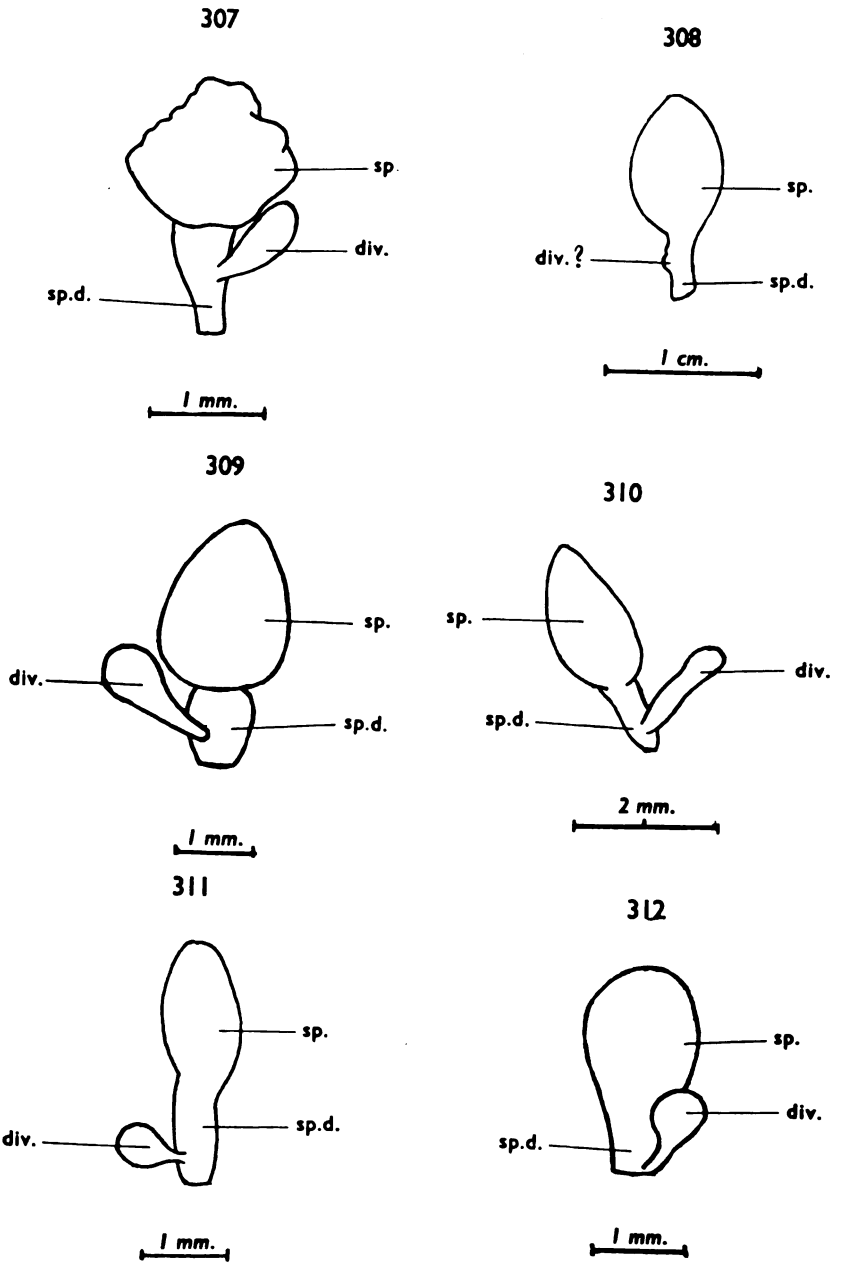

FIG. 307. *Megascolides albus*. Left posterior spermatheca, posterior aspect
FIG. 308. *Megascolides equestris*. Spermatheca. (After Benham, 1942)
FIG. 309. *Megascolides esculentus*. Spermatheca. (After Benham, 1904b)
FIG. 310. *Megascolides fuscus*. Left spermatheca, medial aspect
FIG. 311. *Megascolides irregularis*. Left posterior spermatheca, anterior aspect
FIG. 312. *Megascolides kirki*. Spermatheca. (After Benham, 1904b)

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Localities:

North Island: Same data as type material; 1 specimen. Ahipora, near Kaitaia; subsoil, broadleaved forest; K.E.L., 28/3/49; 2 specimens. Maunu, near Whangarei; topsoil, broadleaved forest; K.E.L., 17/1/49; 3 specimens. Maungakaramea; subsoil, broadleaved forest; K.E.L., 17/1/49; 1 specimen.

Little Barrier Island: Pohutukawa Flat; under stones; J. S. Edwards, 27/8/52; 1 specimen. Waipawa Stm.; topsoil, coastal forest; J. S. Edwards, 29/8/52; 1 specimen. Te Waikohare Stm.; topsoil, coastal forest; J. S. Edwards, 29/8/52; 1 specimen.

Hen and Chicken Islands: Hen Id.; under rocks; H. S. Fairburn, 8/53; 8 specimens. Landing Valley, Inner Chicken Id.; among pebbles under litter of scrub; J. S. Edwards, 21/3/53; 4 specimens. Big Chick Id.; stream bank; topsoil, coastal scrub; M. Esson, 9/55; 4 specimens.

Megascolides kirki (Benham). Fig. 312

1904 *Tokea kirki* Benham, Proc. zool. Soc., Lond., 1904 (2), pp. 251–2.
1905 *Tokea kirki,* Benham, Trans. N.Z. Inst. 37:283.
1907 *Megascolides kirki,* Michaelsen, Fauna Südwest-Aust. 1 (2).
1916 *Notoscolex kirki,* Michaelsen, K. svenska VetenskAkad. Handl. 52:13.
1952 *Megascolides kirki,* Lee, Trans. roy. Soc. N.Z. 80:26.

This species has not been seen in the present investigation. The description given by Benham is incomplete, but would be sufficient for the identification of the species. The following description is taken from Benham (1904) with additional information derived from a re-examination of type material. The figure is copied from Benham.

Length 80–100 mm. Diameter 6 mm. 110 segments.

Colour reddish purple with brownish red clitellum.

Clitellum xiii–xvii, dorsal and lateral.

Prostomium tanylobous.

Chaetae 8/segment, fairly evenly spaced: ab=bc=cd; aa=dd>ab.

Male pores on xviii, each on the edge of a small quadrangular depression, situated on a large flattened papilla, in line with chaeta b.

Female pores on xiv, close together, near anterior margin of segment.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

No specially thickened septa.

Proventriculus in anterior portion of v. Gizzard small, in posterior portion of v. Oesophageal glands in xiv.

Dorsal blood vessel unpaired. Hearts in x, xi, xii, from dorsal blood vessel.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xviii–xxiii; tubular. Spermathecae in viii, ix; large pyriform sac with no distinct duct; small antero-medial diverticulum same shape as sac. (Fig. 312).

Micronephridia in narrow band close to anterior margin of segments.

Type Locality: Ohaeawai, near Kaikohe; W. B. Benham, 1904.

Type material in Otago Museum (No. A.02.137); 5 specimens, well preserved.

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Megascolides maoricus Benham. Fig. 313

1904 *Tokea maorica* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 252-5.
1905 *Tokea maorica,* Benham, Trans. N.Z. Inst. 37:283.
1906 *Tokea maorica* + *Tokea decipiens,* Benham, Trans. N.Z. Inst. 38:239.
1907 *Megascolides maorica* + *Megascolides decipiens,* Michaelsen, Fauna Südwest-Aust. 1 (2).
1916 *Notoscolex maorica* + *Notoscolex decipiens,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1941 *Tokea maorica* + *Tokea decipiens,* Benham, Trans. roy. Soc. N.Z. 71:28.
1952 *Megascolides maorica,* Lee, Trans. roy. Soc. N.Z. 80:27.

Length 70 mm. Diameter 4 mm. 75 segments.

Colour dark purplish brown with reddish brown clitellum.

Clitellum xiii–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc; dd>aa>cd.

Male pores on large, flat, oval papillae on xviii, in line with chaeta a.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores on viii, ix, about half way between chaeta a and posterior segmental margin.

No specially thickened septa.

Gizzard in v, small. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in ix–xii. Hearts from supra-intestinal vessel in x, xi, xii. Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii (not x, xi, xii as stated in Lee (1952)), racemose; those of ix much smaller than those of xi, xii. Prostates arising from ducts in xviii and varying in size and extent; convoluted and tubular. Spermathecae in viii, ix; large ovoidal sac with short duct; very small pyriform diverticulum opening by narrow duct into medial aspect of spermathecal duct. (Fig. 313).

Micronephridia in a broad band across lateral and dorso-lateral aspects of peritoneum.

Type Locality: Auckland, Waitakere Bush; W. B. Benham, 1904.

Type material in Otago Museum (No. A.04.97); 2 specimens, in fair condition.

Localities:

North Island: Tangowahine, near Whangarei; topsoil, broadleaved forest; K.E.L., 15/1/49; 6 specimens. Maungakaramea, near Whangarei; subsoil, broadleaved forest; K.E.L., 17/1/49; 5 specimens. Maunu, near Whangarei; topsoil, broadleaved forest; K.E.L., 17/1/49; 2 specimens. Waimatenui, near Whangarei; topsoil, broadleaved forest; K.E.L., 18/1/49; 2 specimens. Waipoua Forest, Northland; leaf mould, kauri forest; W. R. McGregor, 1/52; 2 specimens.

Little Barrier Island: Thumb Track; under rotten log; J. S. Edwards, 24/8/52; 4 specimens. Hingaia; under stones, coastal forest; J. S. Edwards, 26/8/52; 5 specimens. Foreshore; under stones; J. S. Edwards, 5/54; 1 specimen.

Hen and Chicken Islands: Hen Id.; under logs and stones; H. S. Fairburn, 8/54; 12 specimens. Landing Valley, Inner Chicken Id.; among stones under litter, scrub; J. S. Edwards, 21/3/53; 1 specimen. Landing Valley, Inner Chicken Id.; in superficial humus under litter, scrub; J. S. Edwards, 21/3/53; 11 specimens. Landing Valley, Inner Chicken Id.; damp clay beside stream pool; J. S. Edwards, 21/3/53; 1 specimen. Landing Valley, Inner Chicken Id.; in silt at bottom of pool in stream; J. S. Edwards, 21/3/53; 1 specimen.

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Megascolides mortenseni (Michaelsen). Fig. 314

1923 *Megascolex mortenseni* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:234–7.
1952 *Megascolides mortenseni,* Lee, Trans. roy. Soc. N.Z. 80:27.

Michaelsen's description of this species is based on a single incomplete specimen and the species has not been collected since he described it. For reasons stated previously I regard the species as probably introduced. Michaelsen placed the species in *Megascolex* because, at the time, he had combined *Notoscolex* with *Megascolex,* and since he regarded the New Zealand species of *Megascolides* as being included in the old *Notoscolex,* he included this species in *Megascolex.* The following description, and the figure, are taken from Michaelsen's original account:

Length of fragment 46 mm. Diameter 4·5–5 mm. 82 segments.

Colour reddish grey anteriorly, brownish posteriorly, with yellowish white clitellum.

Clitellum xiii–xviii, complete on xiii–xvii, dorsal and lateral on xviii.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; aa=bc=cd; dd>aa.

Male pores on small, transverse, oval papillae on xviii, medial to chaeta a, close to ventral mid line.

Female pores not visible.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaeta a, very small.

Septa ix/x to xii/xiii thickened; some septa anterior to ix/x are also slightly thickened.

Gizzard in v, small. Intestine commences in xvi.

Last heart in xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, sac-like, irregular. Prostates in xviii, tubular. Spermathecae in vii, viii, ix; long cylindrical sac with duct not sharply set off from sac; slender pyriform diverticulum opens into spermathecal duct. (Fig. 314).

Micronephridia in a band across lateral and dorso-lateral aspects of peritoneum.

Type Locality: Palmerston North; W. Michaelsen, 1923.

Type specimen in University Zoological Museum, Copenhagen, Denmark.

Megascolides napierensis Benham. Fig. 315

1941 *Megascolides napierensis* Benham, Trans. roy. Soc. N.Z. 71:27–31.
1950 *Megascolides napierensis,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:33.
1952 *Megascolides napierensis,* Lee, Trans. roy. Soc. N.Z. 80:27.

This species is known from only one specimen, collected from a nurseryman's glasshouse in Napier, and described by Benham. The following description is taken from the account published by Benham, and the figure is copied from Benham:

Length 550 mm. Diameter 10 mm. Segments not counted.

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Colour chocolate brown with a violet tinge, with darker brown clitellum.

Clitellum ½xii–xviii, complete.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa>bc>ab; dd≫aa.

Male pores on low papillae on xviii, in line with chaeta b.

Female pores on xiv, antero-medial to chaeta a, one on each side of a small pale area.

Spermathecal pores on vi, vii, viii, ix, in the interchaetal space bc (i.e. in the middle of the segment, not at the margin as is usually the case).

Body wall unusually thick. First septum at iv/v. Septa ix/x to xi/xii thickened.

Proventriculus in v–vi. Gizzard in vii, small. No dilated oesophageal glands, but in xiv, xv, xvi the gut wall is highly vascular and may be regarded as analogous to oesophageal glands. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts in xii, xiii, connected to dorsal blood vessel and to supra-intestinal plexus of blood vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, sac-like. Prostates in xviii, apparently lobate, but with single axial canal. (Benham (1941) states that the prostates are in xvii, xix, but since he has described and illustrated only one pair of combined prostatic and male pores, on xviii, I presume that he has made an error in his description.) Spermathecae in vi, vii, viii, ix; large sub-spherical sac with narrow duct; small sub-spherical diverticulum opens by short narrow duct into spermathecal duct. (Fig. 315).

Micronephridia in a narrow line across the lateral aspects of the peritoneum in each segment except i; in the last eighteen to twenty segments the tubules are larger than in the remainder of the segments.

Type Locality: Napier; in a nurseryman's glasshouse; W. B. Benham, 1941.

Type specimen in Otago Museum (No. A.41.9); 1 specimen, in poor condition.

Remarks: Benham did not consider the possibility of this species having been introduced by man and did not compare it with any other species. It is unlike any other New Zealand species in having the gizzard in vii and in its possession of four pairs of spermathecae. The circumstances in which it was found, together with its anatomical peculiarities are strong evidence that it is a recent introduction, unrelated to the New Zealand species of the genus.

Megascolides neglectus Cognetti de Martiis. Fig. 316

1909 *Megascolides neglectus* Cognetti de Martiis, Ann. Mus. Stor. nat. Genova 4 (44):1–3.

The description of this species appears to have been overlooked by previous workers on the New Zealand earthworm fauna. Cognetti de Martiis had only one specimen, collected in 1878. The species has not

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been recorded again, and the following description and figure are taken from Cognetti's account.

Length 75 mm. Diameter 3–4 mm. 104 segments.

Colour brownish yellow (in alcohol).

Clitellum xiii–xviii, complete on xiii–xvii, dorsal only on xviii.

Prostomium epilobous.

Chaetae 8/segment: aa=bc=cd>ab; dd>aa.

Male pores small, on prominent rounded papillae on xviii, in line with chaeta a.

Female pores not visible.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa ix/x to xiii/xiv thickened.

Gizzard in vi. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel not mentioned. Hearts in x, xi, xii, xiii. Testes in x, xi. Vesiculae seminales in ix, xii, those of ix smaller than those of xii. Prostates in xviii–xxiii, tubular, undulating, duct surrounded by glandular mass in xviii and part xix.

Spermathecae in viii, ix; elongate ovoidal sac with short narrow duct; small spheroidal diverticulum opens by short narrow duct into spermathecal duct. (Fig. 316).

Micronephridia very small and numerous.

Type Locality: Titirangi, Auckland; L. Cognetti de Martiis, 1909

Type specimen in Civic Museum of Natural History, Genoa, Italy.

Localities: None.

Collections have been made in the neighbourhood of Titirangi in the course of this investigation, but no specimens of this species have been collected.

Megascolides parvus Lee. Fig. 317

1952 *Megascolides parvus* Lee, Trans. roy. Soc. N.Z. 80:30-1.

Length 26·5 mm. Diameter 3·5 mm. 72 segments.

Colour reddish brown with buff clitellum.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; bc=cd>aa>ab; dd>cd.

Male pores on low, rounded papillae on xviii, in line with chaeta a.

Female pores on xiv, close to anterior margin of segment and to ventral mid line.

Spermathecal pores at 6/7, 7/8, 8/9, medial to line of chaeta a.

Septa vii/viii to xii/xiii thickened.

Gizzard in v, strong. Oesophageal glands in xii. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, small, racemose. Prostates in xviii–xxiii (or xxiv); slender duct passes through xviii–xix, with long, slender, tubular, glandular portion lying

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beneath the intestine in xx–xxiii (or xxiv). Spermathecae in vii, viii, ix; conical sac with short wide duct; small spherical diverticulum opens by short, very slender duct into spermathecal duct. (Fig. 317).

Micronephridia form a compact mat on the lateral aspects of the peritoneum in each segment except i.

Type Locality: 3 miles N.W. of Hicks Bay, near E. Cape; topsoil, broadleaved forest; K.E.L., 11/1/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Waioeka Gorge, 18 miles S. of Opotiki; leaf mould; podocarp-broadleaved forest; D. E. Hurley, 1/51; 1 specimen. Te Hope, Coromandel; leaf mould, forest; T. E. Woodward, 13/1/52; 2 specimens.

Megascolides raglani Lee. Fig. 318

1952 *Megascolides raglani* Lee, Trans. roy. Soc. N.Z. 80:31–2.

Length 81 mm. Diameter 5 mm. 101 segments.

Colour brick red with buff clitellum.

Clitellum xiii–xviii, complete.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; aa=bc>ab; dd>aa.

Male pores on xviii in small oval depressions surrounded by a narrow ridge in position of chaeta a.

Female pore on xiv, unpaired, median ventral, near anterior margin of segment.

Spermathecal pores at 7/8, 8/9, in line with chaetal interval ab.

Septa ix/x to xiii/xiv thickened.

Gizzard in v, large. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in ix, x, xi, xii, those of ix much smaller than those of x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xi, xii, those of ix smaller than those of xi, xii; sac-like. Prostates in xviii–xix; short, curved, tubular organs, lying beneath the intestine. Spermathecae in viii, ix; large spheroidal sac with finger-like lobe projecting over its dorsal surface, opening by a short muscular duct; elongate pyriform diverticulum opening by short narrow duct into medial aspect of spermathecal duct. (Fig. 318).

Micronephridia in a band across the lateral and dorso-lateral aspects of each segment except i; in the eleven most posterior segments there are what appear to be small non-functional meganephridia in addition to the micronephridia.

Type Locality: Hakarimata Range, W. Waikato; topsoil, broadleaved forest; K.E.L., 21/5/50.

Type specimen in Soil Bureau collection.

Remarks: This species, in its general appearance, bears a striking resemblance to *Spenceriella shakespeari,* with which it is sometimes found.

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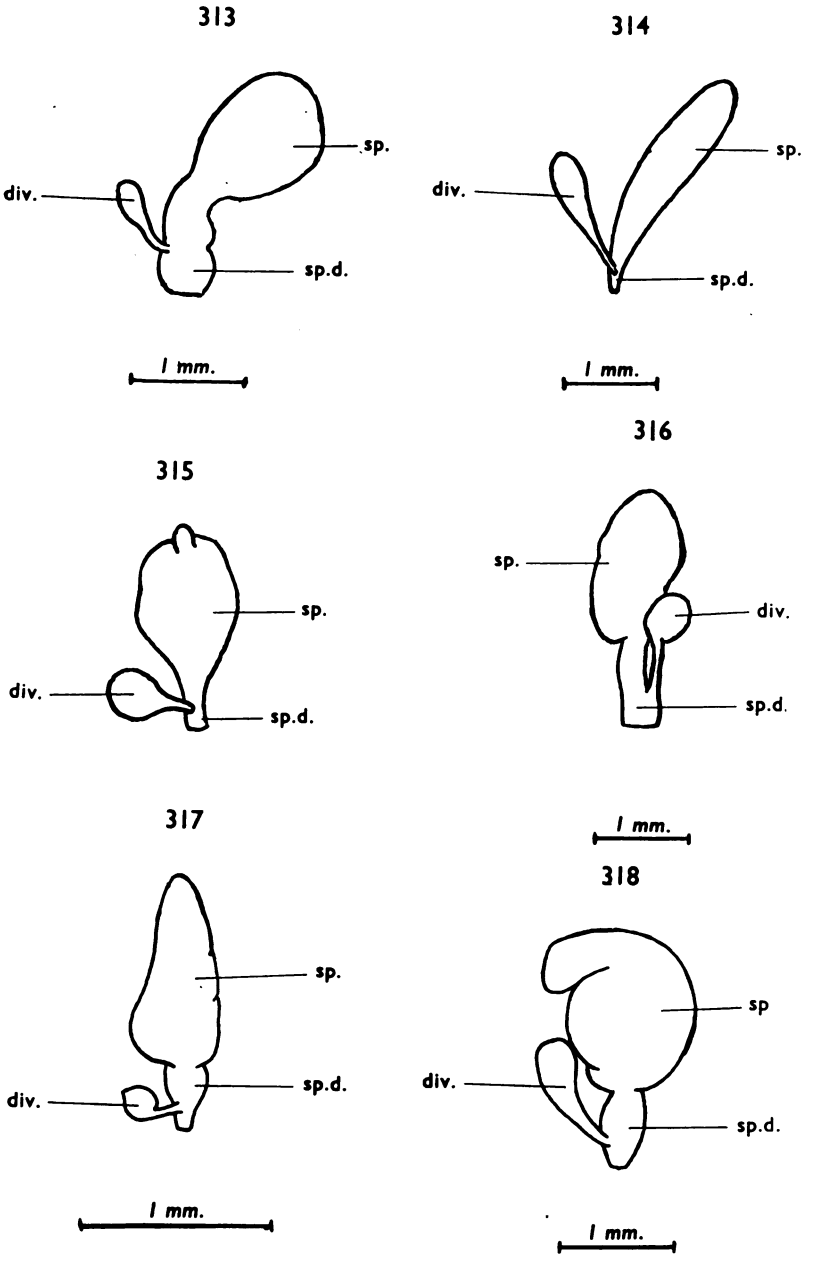

FIG. 313. *Megascolides maoricus*. Left anterior spermatheca, anterior aspect
FIG. 314. *Megascolides mortenseni*. Spermatheca. (After Michaelsen, 1923a)
FIG. 315. *Megascolides napierensis*. Spermatheca. (After Benham, 1941)
FIG. 316. *Megascolides neglectus*. Spermatheca. (After Cognetti de Martiis, 1909)
FIG. 317. *Megascolides parvus*. Right spermatheca of viii, posterior aspect
FIG. 318. *Megascolides raglani*. Right posterior spermatheca, posterior aspect

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Localities:

North Island: Same data as type material; 1 specimen. Ngaroma, near Arapuni; topsoil, podocarp-broadleaved forest; K.E.L., 25/5/50; 2 specimens.

Megascolides reptans (Ude). Fig. 319

1905 *Notoscolex reptans* Ude, Z. wiss. Zool. 83 .
1907 *Megascolides reptans,* Michaelsen, Fauna Südwest-Aust. 1 (2): 161.
1916 *Megascolides reptans,* Michaelsen, K. svenska VentenskAkad. Handl. 52 (13).
1942 *Megascolides reptans,* Benham, Trans. roy. Soc. N.Z. 72:225.
1952 *Megascolides reptans,* Lee, Trans. roy. Soc. N.Z. 80:27.

Length 100 mm. Diameter 5 mm. 100 segments.

Colourless (in alcohol); brick red dorsally, pale ventrally, with pale brown clitellum (alive).

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: aa=bc=cd=dd>ab.

Male pores on small papillae on xviii, in position of chaeta a.

Female pores not visible.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa vii/viii to xiv/xv thickened.

Gizzard in vi. Oesophageal glands in x, xi, xii, xiii, xiv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose; those of ix smaller than those of xii, which are smaller than those of x, xi. Prostates in xviii–xxiii, tubular; ventral to intestine. Spermathecae in viii, ix; large pyriform sac with narrow duct; small slender pyriform diverticulum opens into spermathecal duct. (Fig. 319).

Micronephridia in each segment except ii.

Type Locality: Tauranga; H. Ude, 1905.

The type material of this species has not been located.

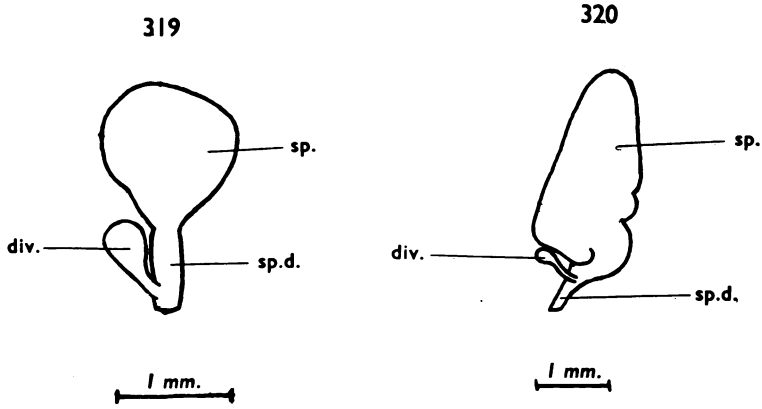

FIG. 319. *Megascolides reptans.* Spermatheca
FIG. 320. *Megascolides ruber.* Left posterior spermatheca, lateral aspect

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Localities:

Mayor Island (Bay of Plenty): L. Aroaro-tamahine; topsoil, pine forest; J. S. Edwards, 23/11/52; 2 specimens. Crater Mound; topsoil, coastal forest; J. S. Edwards, 23/11/52; 1 specimen.

Megascolides ruber Lee. Fig. 320

1952 *Megascolides ruber* Lee, Trans. roy. Soc. N.Z. 80:29–30.

Length 70–80 mm. Diameter 4–5 mm. c.80 segments.

Colour dark red with paler red clitellum.

Clitellum xiv–xviii, complete.

Prostomium epilobous.

Chaetae 8/segment: dd>cd>bc>ab; aa=bc.

Male pores on xviii, in small cup-like depressions surrounded by a narrow ridge, in line with chaetal interval ab.

Female pore on xiv, unpaired, median ventral, close to anterior margin of segment.

Spermathecal pores at 7/8, 8/9, in line with chaeta b.

No specially thickened septa.

Gizzard in v, small. Oesophageal glands in xii, xiii. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii, each consisting of a number of moniliform threads. Vesiculae seminales in xi, xii, small, racemose; masses of loosely packed sperm cells occur in x, xi. Prostates in xviii–xx (or xxi), tubular; lying under the intestine for most of their length. Spermathecae in viii, ix; large, thin walled, ovoidal sac with narrow duct; very small pyriform diverticulum opens by short narrow duct into anterior aspect of spermathecal duct. (Fig. 320).

Micronephridia in a band across the lateral and dorso-lateral aspects of the peritoneum in each segment except i.

Type Locality: Mangamuku Ra., Northland; subsoil, podocarp-broad-leaved forest; K.E.L., 23/3/49.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen.

Three Kings Islands; Tasman Stm. valley, Great Id.; leaf mould, coastal forest; J. S. Edwards, 5/1/53; 3 specimens. Tasman Stm. valley; topsoil, coastal forest; J. S. Edwards, 5/1/53; 3 specimens.

Megascolides rubicundus n.sp. Figs. 321–323

Length 114 mm. Diameter of normal body segments 4·5 mm.; of clitellum 5·5 mm. 97 segments.

Colour purplish red with long, very prominent, brick red clitellum.

Clitellum xiv–xxviii, complete on xiv–xvii, dorsal and lateral on xviii–xxviii. No other New Zealand species of the genus has such an extensive clitellum.

Prostomium epilobous.

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Chaetae 8/segment: ab=cd; aa>bc>dd>ab.

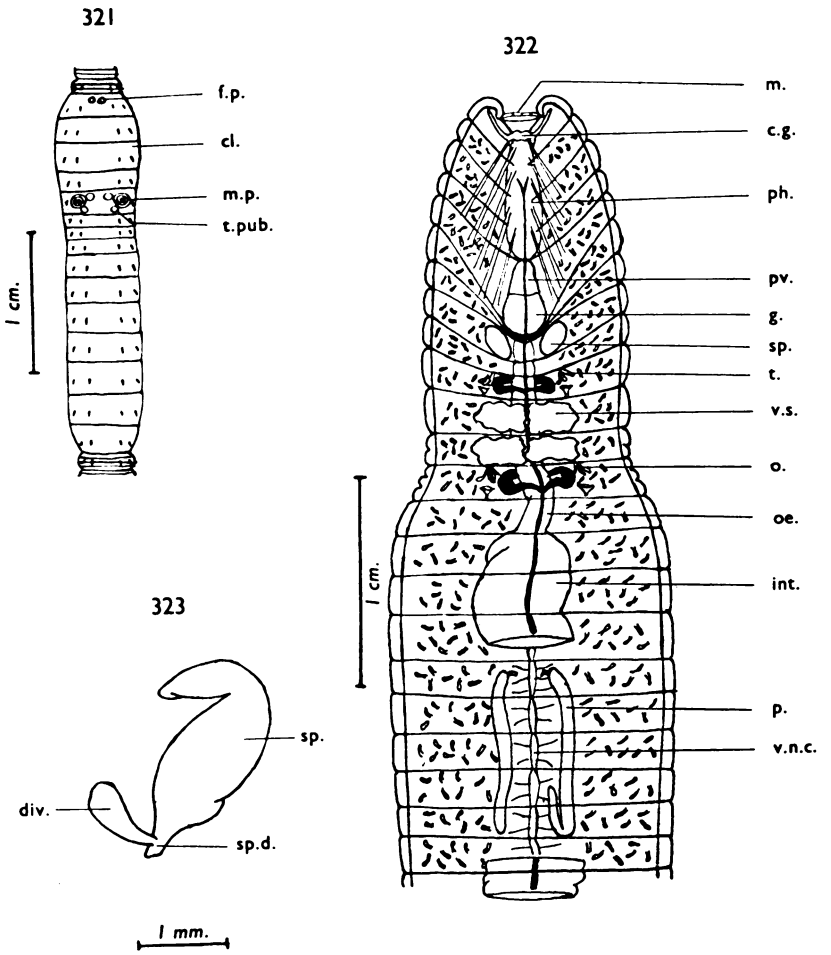
Male pores on xviii, each in a small oval depression surrounded by a narrow ridge, in position of chaeta a; a pair of small papillae is associated with each of the male pores, one lying antero-medial and the other postero-medial to the edge of the depression containing the pore. (See Fig. 321).

Female pores on xiv, very close together, one each side of ventral mid line, close to anterior margin of segment.

Spermathecal pores at 7/8, in line with chaeta a.

No specially thickened septa.

Pharynx in i–iv, very long and narrow (6·5 mm. × 1·5 mm. in type specimen). Proventriculus in anterior portion of v; long, narrow, thin



FIGS. 321–323. *Megascolides rubicundus* n.sp.
321. Ventral aspect, segments xiii–xxix
322. Dissection from dorsal aspect, segments i–xxiii
323. Left spermatheca, anterior aspect

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walled. Gizzard in posterior portion of v, bulbous and thick walled. Oesophageal glands absent. Intestine commences in xv.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose, large. Prostates in xviii–xxii, tubular; lying beneath the intestine. Spermathecae in viii; elongate ovoidal sac, folded sharply upon itself distally, with short narrow duct; small, slender, pyriform diverticulum opens by short narrow duct into medial aspect of spermathecal duct. (Fig. 323).

Micronephridia in each segment except i; individual tubules small and scattered all over the lateral aspects of the peritoneum.

Type Locality: Little Barrier Island, near Thumb Track at about 1,800 ft. above sea level; topsoil, broadleaved forest; J. S. Edwards, 24/8/52.

Type specimen in Soil Bureau collection.

Localities:

Little Barrier Island: Same data as type material; 1 specimen.

Megascolides sapidus (Benham). Fig. 324

1904 *Tokea sapida* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 245–6.
1905 *Tokea sapida,* Benham, Trans. N.Z. Inst. 37:283.
1906 *Tokea sapida,* Benham, Trans. N.Z. Inst. 38:239.
1916 *Notoscolex sapida,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1952 *Megascolides sapida,* Lee, Trans. roy. Soc. N.Z. 80:27.

This species has not been collected since it was first described by Benham (1904). I have re-examined the type material and the following description is that of Benham, with additional notes based on my re-examination. The figure is copied from Benham.

Length 200 mm. Diameter 8 mm. 190 segments; the post-clitellar segments are biannulate.

Colour dark brown when alive, purplish red in formalin, with darker red clitellum; some specimens are marbled with paler streaks and patches posteriorly.

Clitellum (xiii)xiv–xviii(xix); complete on xiv–xvii, dorsal and lateral on xviii; when present on xiii and xix dorsal only.

Prostomium prolobous.

Chaetae 8/segment: ab=cd; aa>bc>ab; dd≫aa.

Male pores on xviii, one at each end of a median ventral oval depression, surrounded by a pale transverse ridge, slightly medial to chaeta b.

Female pores on xiv, anterior to chaeta b.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaetal interval ab.

Septa vi/vii to xiii/xiv thickened.

Gizzard in v. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts in x, xi, xii, xiii, connected to dorsal and supra-intestinal blood vessels.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, sac-like. Prostates in xviii–xxvi, tubular, ventral to intestine. Spermathecae

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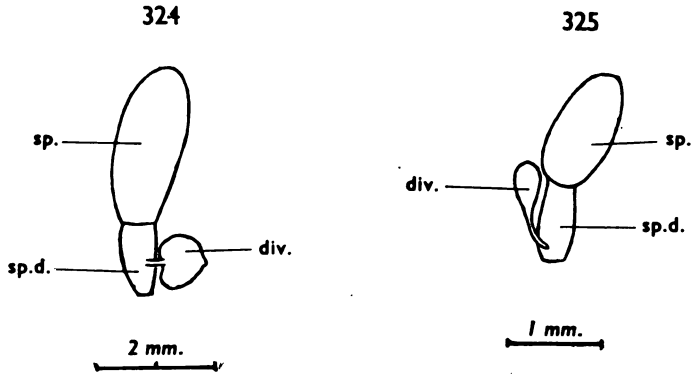

FIG. 324. *Megascolides sapidus*. Spermatheca. (After Benham, 1904b)
FIG. 325. *Megascolides suteri*. Spermatheca. (After Benham, 1904b)

in vii, viii, ix; elongate ovoidal sac with long thick duct; small globular diverticulum opens by short narrow duct into spermathecal duct. (Fig. 324).

Micronephridia in each segment except ii; broad band of tubules extending across ventro-lateral and lateral aspects of peritoneum.

Type Locality: Ruatahuna, central North Island; W. B. Benham, 1904.

Type material in Otago Museum (No. A.02.136); 1 specimen, in good condition; 5 other specimens, also in good condition.

Megascolides suteri (Benham). Fig. 325

1904 *Tokea suteri* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 250-1.
1905 *Tokea suteri*, Benham, Trans. N.Z. Inst. 37:283.
1916 *Notoscolex suteri*, Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1952 *Megascolides suteri*, Lee, Trans. roy. Soc. N.Z. 80:36.

Length 50 mm. Diameter 5 mm. 86 segments.

Colour irridescent purplish red with red-brown clitellum.

Clitellum xiii–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: aa=ab=bc=dd>cd.

Male pores on small papillae on xviii, in position of chaeta a.

Female pores on xiv, anterior and slightly medial to chaeta a.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaeta a.

Septa viii/ix to xii/xiii thickened.

Proventriculus in v, short, thin walled. Gizzard in vi, feebly developed.

Oesophagus slightly dilated in xii. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi, small, folded, laminar organs. Ovaries in xiii, larger, thicker, laminar organs. Vesiculae seminales in ix, xii, racemose. Prostates in xviii–xxiii, tubular, ventral to intestine. Spermathecae in

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vii, viii, ix; elongate ovoidal sac with long duct; slender pyriform diverticulum opens into duct. (Fig. 325).

Micronephridia in each segment except i; tubules in densely packed mass over ventro-lateral aspects of peritoneum, less numerous laterally and absent dorso-laterally.

Type Locality: Auckland; W. B. Benham, 1904. The type material of this species has not been located.

Localities:

North Island: Titirangi, Auckland; leaf mould, forest; T. E. Woodward, 19/12/51; 1 specimen. 9 miles S. of Rotorua; in rotten tawa log; K.E.L., 6/10/49; 10 specimens. Waitaia Stm., W. Taupo; in rotten totara and miro logs; A. C. S. Wright, 7/1/50; 7 specimens. Torere, near Opotiki; topsoil, coastal forest; K.E.L., 12/1/51; 1 specimen. Waioeka Gorge, 17 miles S. of Opotiki; rotten log; K.E.L., 13/1/51; 1 specimen. Cape Runaway; rotten kahikitea log; K.E.L., 11/1/51; 1 specimen. 10 miles S. of Te Araroa; rotten kahikitea log; K.E.L., 10/1/51; 1 specimen.

Poor Knights Islands: Humus under litter, coastal forest; J. S. Edwards, 27/12/52; 1 specimen. Topsoil, coastal forest; J. S. Edwards, 27/12/52; 3 specimens.

Little Barrier Island: Summit track; in beech log; J. S. Edwards, 5/54; 2 specimens.

Megascolides tasmani n.sp. Figs. 326–328

Length 67·5 mm. Diameter 6 mm. 132 segments.

Colour purplish red dorsally, pale ventrally, clitellum darker in colour than adjacent segments but not noticeably thickened.

Clitellum xiii–xviii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: dd>bc>aa>cd>ab.

Male pores on small, oval, flattened pads, in position of chaeta a.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, slightly medial to line of chaeta a.

Septa viii/ix to xiii/xiv thickened.

Pharynx in i–iv covered dorsally and laterally by masses of salivary glands. Gizzard in v, very small. Oesophageal glands absent. Intestine commences in xvi.

Dorsal blood vesssel unpaired anterior to x/xi; paired from x/xi to xv/xvi but the two vessels fuse at each septum; unpaired posterior to xv/xvi. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii.

Testes and ovaries not visible, but paired testicular funnels present in x, xi, and paired oviducal funnels in xiii. Vesiculae seminales in ix, xii, racemose, small. Prostates in xviii–xx, tubular, convoluted, lateral to intestine. Spermathecae in viii, ix; small rounded sac with thick muscular duct; small pyriform diverticulum opening by short narrow duct into medial aspect of spermathecal duct. (Fig. 328).

Micronephridia commence in ii; small cluster of tubules on ventro-lateral aspect of peritoneum on each side of each segment.

Type Locality: Beside Tasman Stm., Great Id., Three Kings Islands; in wet gravel; J. S. Edwards, 31/12/52.

Type specimen in Auckland Museum collection.

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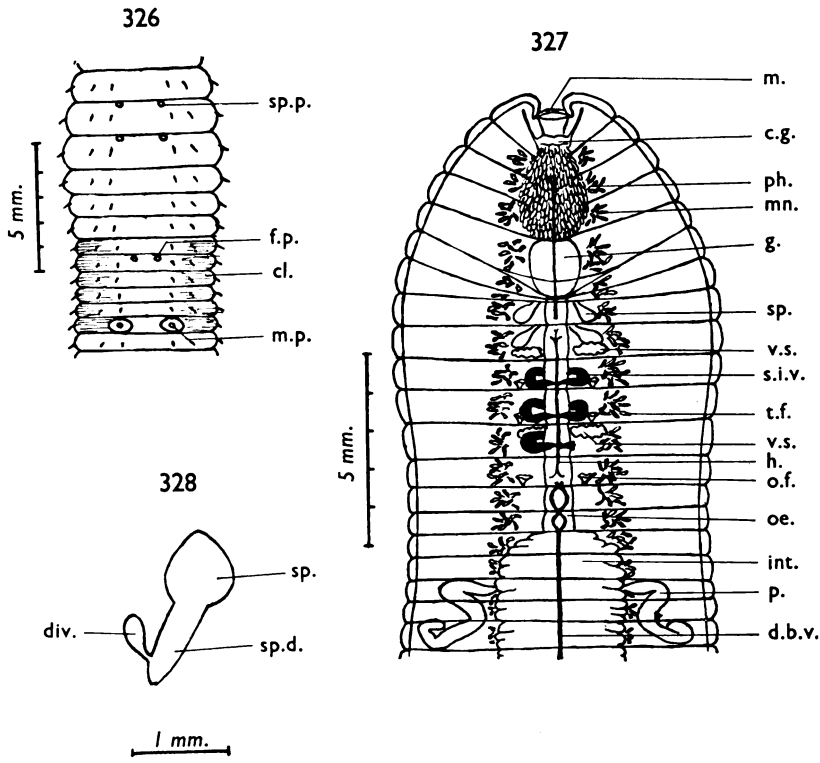

FIGS. 326–328. *Megascolides tasmani* n.sp.
326. Ventral aspect, segments vii-xix
327. Dissection from dorsal aspect, segments i–xx
328. Right anterior spermatheca, posterior aspect

Localities:

Great Id., Three Kings Is.: Same data as type material; 1 specimen. Tasman Stm. valley; under hepatic on damp streamside rock; J. S. Edwards, 5/1/53; 1 specimen.

Megascolides unipapillatus (Ude).

1905 *Notoscolex unipapillatus* Ude, Z. wiss. Zool. 83.
1916 *Megascolides unipapillatus,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1942 *Megascolides unipapillatus,* Benham, Trans. roy. Soc. N.Z. 72:225.
1952 *Megascolides unipapillatus,* Lee, Trans. roy. Soc. N.Z. 80:27.

Length 40 mm. Diameter 3 mm. 80 segments.

Colourless (in alcohol).

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: dd>cd>bc>aa>ab.

Male pores on xviii, on lateral borders of a transverse oval depression, in position of chaeta a.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

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Septa viii/ix to xiv/xv thickened.

Gizzard in v. Oesophageal glands in ix, x, xi, xii, xiii. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in x, xi, xii, those of xii smaller than those of x, xi. Prostates in xviii–xvi, tubular, lying beneath the intestine; the two ducts pass through the body wall close to the ends of a transverse, oval glandular cushion, on the peritoneum, corresponding in position to the external depression between the male pores. Spermathecae in viii, ix; elongate ovoidal sac with short narrow duct not sharply divided from sac; small pyriform diverticulum opens into spermathecal duct.

Micronephridia very numerous in segments.

Type Locality: Tauranga; H. Ude, 1905.

Remarks: Ude (1905) thought that this species might be identical with a species proposed by Schmarda (1861), listed here as *Megascolides orthostichon* sp. inc. sed.

Megascolides urewerae (Benham). Fig. 329

1904 *Tokea urewerae* Benham, Proc. zool. Soc. Lond., 1904 (2), pp. 246–8.
1905 *Tokea urewerae,* Benham, Trans. N.Z. Inst. 37:283.
1916 *Notoscolex urewerae,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1952 *Megascolides urewerae,* Lee, Trans. roy. Soc. N.Z. 80:36–7.

Length 65–80 mm. Diameter 7–8 mm. 78 segments.

Colour pale brownish-white with orange-brown clitellum.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: aa=ab=cd; dd>bc>aa.

Male pores on xviii, each pore in a small sub-circular depression with distinct raised margin, in line with chaeta a.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores on hinder margins of vi, vii, viii, in line with chaeta a.

Septa vi/vii to xii/xiii thickened.

Gizzard in v, long and narrow. Oesophagus dilated in xi, xii, xiii, xiv, xv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, x, xi, xii, racemose. Prostates in xviii–xxvi, tubular, lying ventral to the intestine. Spermathecae in vii, viii, ix; large ovoidal sac with long narrow duct which passes through the septum to open at the posterior end of the next anterior segment; slender pyriform diverticulum with narrow duct opens into spermathecal duct. (Fig. 329).

Micronephridia slender, distributed across ventro-lateral and lateral aspects of the peritoneum; meganephridia also present in last 12–15 segments.

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Type Locality: Ruatahuna, Urewera Country, North Island; W. B. Benham, 1904.

Type material in Otago Museum (No. A.02.138); 2 specimens, in good condition.

Localities:

Waioeka Gorge, 27 miles S. of Opotiki; topsoil, forest; K.E.L., 13/1/51; 1 specimen. Motuhora; leaf mould, forest; K.E.L., 13/1/51; 1 specimen.

Megascolides viridis Lee. Fig. 330

1952 *Megascolides viridis* Lee, Trans. roy. Soc. N.Z. 80:28–9.

Length 54 mm. Diameter 4·5 mm. 66 segments.

Colour reddish brown dorsally, blue-green ventrally, each chaeta arising from the centre of a small, round, raised spot; clitellum same colour as remainder of body.

Clitellum xiv–xvii, complete.

Prostomium prolobous.

Chaetae 8/segment: bc=cd>ab; dd>aa>bc.

Male pores on small round white papillae, slightly lateral to line of chaeta a.

Female pores on xiv, antero-medial to chaeta a.

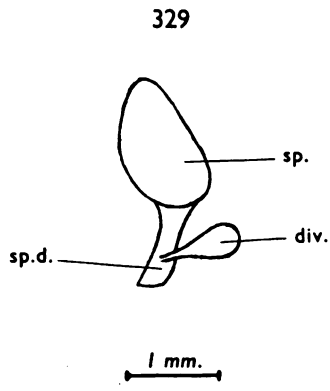
Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Septa vii/viii to xiii/xiv thickened.

Gizzard in v, slender, but with thick walls. Oesophageal glands absent. Intestine commences in xv.

Dorsal blood vessel unpaired. Supra-intestinal vessel commences in x. Hearts from supra-intestinal vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii, consisting of a number of filiform processes. Vesiculae seminales in ix, x, xi, xii, those of ix and xii much smaller than those of x and xi. Prostates extending back from xviii through varying number of segments, tubular, ventral to intestine for most of length. Spermathecae in viii, ix; large ovoidal sac with



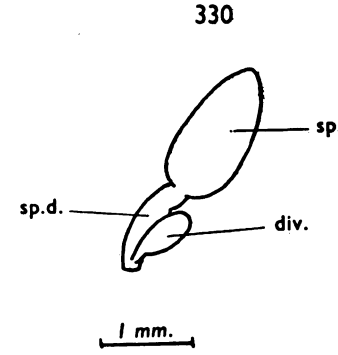


FIG. 329. *Megascolides urewerae.* Spermatheca

FIG. 330. *Megascolides viridis.* Left anterior spermatheca, anterior aspect

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long, curved, muscular duct; slender pyriform diverticulum without distinct duct opens into medial aspect of spermathecal duct. (Fig. 330).

Micronephridia in a broad band across the ventro-lateral and lateral aspects of peritoneum in each segment except i.

Type Locality: 7 miles W. of Motuhora, near Gisborne; leaf mould, forest; K.E.L., 13/1/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 2 specimens. Waioeka Gorge; leaf mould, forest; D. E. Hurley, 13/1/51; 3 specimens.

Genus Notoscolex Fletcher

1886 *Notoscolex* + *Cryptodrilus* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 1:546, 570.
1889 Subgen. *Notoscolex* (part) + *Cryptodrilus* (part), Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 3:1525, 1532.
1890 *Deodrilus* Beddard, Quart. J. micr. Sci. 31:467.
1892 *Megascolides* (part), Spencer, Proc. roy. Soc. Vict. 4:144.
1900 *Notoscolex* + *Megascolides* (part), Michaelsen, Tierreich 10:187.
1928 *Megascolex* (part), Michaelsen, Handb. Zool., Berl., 2:110.
1930 *Notoscolex* (part), Stephenson, Oligochaeta p. 836.
1952 *Notoscolex,* Lee, Trans. roy. Soc. N.Z. 80:37.

This is a large genus, known principally from Australia. The definition given below is that of Stephenson (1930, p. 836). It is not a good definition.

Chaetae eight per segment. Spermathecal pores one, two or three pairs, the last in furrow 8/9 (in certain abnormal species in 7/8). One gizzard in segment v or vi. Micronephridia present, sometimes with meganephridia also. Prostates with branched system of ducts.

Type species: *Notoscolex camdenensis* Fletcher. New South Wales, Australia.

Number of Species: About seventy, including one from New Zealand.

Distribution: India and Ceylon; Australia; New Zealand—confined to the north of the North Island (Fig. 366).

The relationships of this genus to *Megascolides* are discussed on p. 259).

One species of the genus is recorded from New Zealand. It was originally found living under a hedge at Kerikeri, and was probably introduced from Australia. One specimen is recorded from Pukekohe in the present investigation.

Notoscolex hakeaphilus Benham. Fig. 331

1949 *Notoscolex hakeaphilus* Benham, Trans. roy. Soc. N.Z. 77:346–50.
1952 *Notoscolex hakeaphilus,* Lee, Trans. roy. Soc. N.Z. 80:37.

Length 650 mm. Diameter 12 mm.

Colour reddish brown anteriorly, becoming paler and ultimately cream posteriorly, with pale brown clitellum.

Clitellum xiii–xviii, complete.

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Prostomium epilobous.

Chaetae 8/segment; not in regular lines: aa is almost constant but the remainder of the chaetae are irregularly arranged.

Male pores on xviii, on small papillae, one on each side of a median ventral, transverse, oval depression.

Female pores on xiv, ventro-lateral.

Spermathecal pores at 7/8, 8/9, ventro-lateral.

Septa v/vi to xi/xii thickened. Septa absent anterior to v/vi.

Gizzard in v. Oesophageal glands in viii. Intestine commences in xii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in viii, ix, x.

Testes in xi. Ovaries in xiii. Vesiculae seminales in xii, racemose. Prostates in xviii–xxiv, flat, tongue-shaped glands, with sides incised by septa; prostates lie beneath the intestine. The prostates have no axial canal, such as is found in the New Zealand species of *Megascolides*, and therefore the species is included in *Notoscolex*. Prostatic ducts pass through a mushroom-shaped glandular mass corresponding to the external depression in which the prostatic papillae are situated. Spermathecae in viii, ix; very long, narrow, cylindrical sac with short duct; small globular diverticulum opens into duct close to body wall. (Fig. 331).

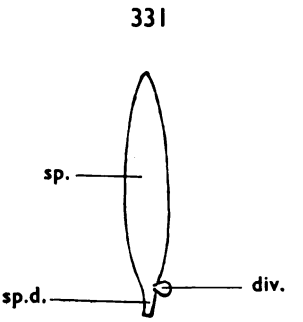

FIG. 331. *Notoscolex hakeaphilus*. Spermatheca. (After Benham, 1949a)

Micronephridia densely packed in anterior segments, becoming less numerous posteriorly.

Type Locality: Kerikeri; W. B. Benham, 1949.

Type specimen in Otago Museum (No. A.48.31); 1 specimen, in poor condition.

Localities:

North Island: Pukekohe, suburb of Auckland; subsoil; W. Cottier, 1951; 1 specimen.

Genus PERIONYX Perrier

1872 *Perionyx* Perrier, Nouv. Arch. Mus. Hist. nat., Paris, 8:126.
1889 *Megascolex* (part), Vaillant, Hist. nat. Annel. 3 (1):62.
1895 *Perionyx*, Beddard, Monograph p. 435.
1900 *Perionyx* + *Diporochaeta* (part), Michaelsen, Tierreich 10:207.
1907 *Perionyx* + *Perionychella*, Michaelsen, Fauna Südwest-Aust. 1 (2):163.
1909 *Diporochaeta* (part), Benham, Subant. Is. N.Z. 1:283–9.
1916 *Perionyx* (part), Michaelsen, K. svenska VetenskAkad. Handl. 52:7.
1923 *Perionyx* (*Perionyx*), Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:232.
1930 *Perionyx*, Stephenson, Oligochaeta p. 841.
1952 *Perionyx*, Lee, Trans. roy. Soc. N.Z. 80:43.

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Since there are only four species of this large genus in the New Zealand region, the following definition has been taken from Stephenson (1930, p. 841) and amended slightly to include the New Zealand species.

Chaetae numerous (more than eight) per segment, in rings which are often almost completely closed. Male pores on xviii, often very close to ventral mid line, not always on papillae. Female pores on xiv, paired and ventro-lateral or unpaired, median ventral. Spermathecal pores ventro-lateral, frequently close to ventral mid line, up to seven pairs, anterior to ix. Gizzard sometimes absent, if present, single, in v or vi or v–vi. Testes and funnels two pairs, in x, xi. Prostates one pair, opening to the exterior in xviii, with branched system of ducts. Meganephridial; nephridial vesicles sometimes present.

Type species: *Perionyx excavatus* Perrier. Phillipine Is.

Number of Species: About fifty.

Distribution: India; Ceylon; Australia; New Zealand. Within the New Zealand region, three species are known from Auckland Islands and one from Mt. Egmont, in the west of the North Island. (Fig. 367).

The relationships of this genus to *Diporochaeta* have been discussed under the latter genus. *Perionyx* also closely resembles *Megascolex,* from which it is differentiated principally by having meganephridia, while *Megascolex* has micronephridia, and *Spenceriella,* from which it is differentiated by the form of the nephridia and by the form of the prostates, *Spenceriella* having tubular prostates.

Key to the New Zealand Species of Perionyx

a$_1$ Gizzard lacking

b$_1$ Spermathecae two pairs, in viii, ix, each with a single tubular diverticulum ..... **P. helophilus**

b$_2$ Spermathecae three pairs, in vii, viii, ix, each with two small ovoidal diverticula, one antero-lateral, one antero-medial ..... **P. perionychopsis**

a$_2$ Gizzard present

c$_1$ Gizzard in v–vi; spermathecae four pairs, in v, vi, vii, viii, each with one small, slender, pyriform, anterior diverticulum ..... **P. egmonti**

c$_2$ Gizzard in vi; spermathecae three pairs, in vii, viii, ix, each with two small ovoidal diverticula, one antero-lateral, one antero-medial ..... **P. shoeanus**

Of the four species of *Perionyx* recorded from the New Zealand region, three have been collected from the Auckland Islands, and one from Taranaki, on the western side of the North Island.

The three species from the Auckland Islands may be distinguished from the North Island species by the degree of development of the gizzard. *P. helophilus* and *P. perionychopsis* have no gizzard, *P. shoeanus* has a very small gizzard, while *P. egmonti,* the North Island species, has a large strong gizzard. *P. shoeanus* and *P. perionychopsis* are, apart from the degree of development of the gizzard, very similar (see Table 17) and differ considerably from *P. helophilus. P. egmonti* does not closely resemble any of the Auckland Island species. It differs in the degree of development of the gizzard, the number and position of oesophageal glands, hearts, vesiculae seminales, and spermathecae.

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TABLE 17. Perionyx

——	*egmonti*	*helophilus*
Length	138 mm.	26–47 mm.
Diameter	10 mm.	1 mm.
Segments	156	47–98
Colour	brick red	chocolate brown, chaetae on white spots
Clitellum	xiii–xvii	xiv–xvii
Extent of clitellum	complete	complete
Prostomium	epilobous	epilobous
Chaetae/segment	c. 80	24
Male papillae	small	absent
Position of male pores ..	b	lateral to b
Position of female pores ..	anterior to a	anterior to a
Position of spermathecal pores ..	ant. margins of v, vi, vii, viii	7/8, 8/9 b
Position of nephridiopores ..	ventral	ventro-lateral
Septal thickening	vii/viii–xiii/xiv	absent
Proventriculus	absent	absent
Gizzard	v–vi	absent
Nature of gizzard	large, strong	..
Oesophageal glands	vii, viii, ix; xiii, xiv	xiii–xiv (one pair)
1st intestinal segment ..	xvii	xvii
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	4	2
Last heart	xiii	xii
Origin of hearts	supra-intest. b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, x, xi, xii botryoidal	ix, xii botryoidal
Prostates	xviii	xviii–xx
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	v, vi, vii, viii	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	small, slender, pyriform	tubular
Position	anterior	medial
Nephridial vesicles	present	absent

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TABLE 17. Perionyx—*continued*

perionychopsis	*shoeanus*
225 mm.	165 mm.
6 mm.	5–6 mm.
200	205
deep crimson	brown
(xiii) xiv–xviii	xiii–xix (xx)
complete except for small mid ventral area	xiv–xvii complete; elsewhere dorsal and lateral
epilobous	epilobous
50–60	c. 48
absent	absent
medial to a	a
near ventral	near ventral
mid line	mid line
6/7, 7/8, 8/9	6/7, 7/8, 8/9
b	a/b
lateral	lateral
x/xi–xv/xvi	vi/vii–xv/xvi
absent	absent
absent	vi
..	small
absent	absent
xviii	xvii
unpaired	unpaired
3	3
xii	xii
dorsal b.v.	supra-intest. b.v.
x, xi	x, xi
ix, xii	ix, xii
racemose	racemose
xviii	xviii
absent	absent
absent	absent
vii, viii, ix	vii, viii, ix
2	2
small, ovoidal	small, ovoidal
1 antero-lateral	..
1 antero-medial	..
present	absent

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Perionyx egmonti Lee. Fig. 332

1952 *Perionyx egmonti* Lee, Trans. roy. Soc. N.Z. 80: 43–4.

Length 138 mm. Diameter 10 mm. 156 segments.

Colour brick red with pink clitellum.

Clitellum xiii–xvii, complete.

Prostomium epilobous.

Chaetae c.80/segment, unpaired, evenly spaced except for wider dorsal and ventral gaps.

Male pores on small papillae on xviii, in position of chaeta b; the papillae lie on the lateral boundaries of an oval "male field", bounded anteriorly and posteriorly by the boundaries of xviii.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at anterior margins of v, vi, vii, viii, 0·75 mm. from ventral mid line.

Nephridiopores ventral, about 1 mm. from ventral mid line.

Septa vii/viii to xiii/xiv thickened and muscular.

Gizzard in v–vi, large and thick walled. Oesophageal glands in vii, viii, ix, xiii, xiv; in addition a pair of small laminar glandular structures is pressed against the lateral walls of the oesophagus in vii, and opens into the oesophagus in vii, through narrow ducts.

Intestine commences in xvii.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in x–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii; small laminar organs with fimbriate free edge. Vesiculae seminales in ix, x, xi, xii, botryoidal. Prostates in xviii; dorso-ventrally flattened, mushroom-shaped glands enclosed in a transparent sheath, and divided, within the sheath, into a number of small lobes, each of which opens by a small canal into a central cavity, which opens into the prostatic duct. Spermathecae in v, vi, vii, viii; long tubular sac with narrow duct; small, slender pyriform diverticulum opens into anterior aspect of spermathecal duct. (Fig. 332).

Nephridia with small vesicles.

Type Locality: Mt. Egmont, near Stratford Mountain House; surface after heavy rain; K.E.L., 27/5/50.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 1 specimen. Near Raurimu; subsoil, podocarp forest; K.E.L., 15/5/50; 1 specimen.

Perionyx helophilus (Benham). Fig. 333

1909 *Diporochaeta helophila* Benham, Subant. Is. N.Z. 1:283–4.
1923 *Perionyx* (*Perionyx*) *helophilus,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75: 232.
1950 *Diporochaeta helophila,* Benham, N.Z. Dep. sci. industr. Res. Cape Exped. Bull. 10:30.
1952 *Perionyx helophilus,* Lee, Trans. roy. Soc. N.Z. 80:43.

This species has not been collected in the present investigation and the following description is based on those of Benham (1909) and

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Michaelsen (1923), with additional information derived from a re-examination of Benham's specimens. The figure is copied from Benham (1909).

Length 26–47 mm. Diameter 1 mm. 47–98 segments.

Colour very dark chocolate brown with paler brown clitellum; chaetae arise from round white spots.

Clitellum xiv–xvii, complete.

Prostomium epilobous.

Chaetae 24/segment, rather unevenly spaced, with dorsal and ventral gaps greater than normal interchaetal space.

Male pores on xviii, surrounded by small white rings, slightly lateral to chaeta b.

Female pores on xiv, surrounded by small white rings, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, about in line with chaeta b.

Nephridiopores about in line with chaeta b.

No specially thickened septa.

Pharynx in i–vi. Gizzard absent. Oesophageal glands in xiii–xiv, not constricted at septum xiii/xiv. Intestine commences in xvii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel, in xi, xii.

Testes in x, xi. Ovaries in xiii, very large. Vesiculae seminales in ix, xii, botryoidal. Prostates in xviii–xx, with ramifying system of ducts. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; sub-spherical sac with short wide duct; tubular diverticulum opens into medial aspect of spermathecal duct (Fig. 333).

Nephridia of large size, without vesicles.

Type Locality: Auckland Islands; W. B. Benham, 1909.

Type ? material in Otago Museum. Four tubes, containing a number of specimens, no type specimen designated. The 4 tubes are Nos. A.07.273, A.07.276, A.07.292 and A.07.302.

Previous Records:

Auckland Islands: (1) Bush soil, north arm of Carnley Harbour; (2) At mouth of fresh water creek as it falls into a pool; (3) 200 ft. above Watering Creek, Camp Cove, in somewhat swampy ground; (4) Enderby Id., in a log near a pool. (All records from Benham, 1909). Main Id., under wood and stones. (From Michaelsen, 1923).

Perionyx perionychopsis (Benham). Fig. 334

1909 *Diporochaeta perionychopsis* Benham, Subant. Is. N.Z. 1:286–9.
1923 *Perionyx* (*Perionyx*) *perionychopsis,* Michaelsen, Vidensk. Medd. dansk. naturh. Foren. Kbh. 75:232.
1950 *Diporochaeta perionychopsis,* Benham, N.Z. Dep. sci. industr. Res: Cape Exped. Bull. 10:31.
1952 *Perionyx perionychopsis,* Lee, Trans. roy. Soc. N.Z. 80:43.

This species, like the previous one has not been re-collected in the course of the present work. The following description and figure, therefore, are taken from Benham (1909), with some additional information derived from a re-examination of type material.

Length 225 mm. Diameter 6 mm. 200 segments; post-clitellar segments triannulate.

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Colour deep crimson red with paler clitellum.

Clitellum (xiii)xiv–xviii, complete except for narrow mid ventral area.

Prostomium epilobous.

Chaetae about 50–60/segment, with small ventral and dorsal gaps.

Male pores on xviii, not on papillae, slightly medial to chaeta a.

Female pores close to ventral mid line, near anterior margin of xiv.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaeta b.

Nephridiopores at the level of about the 15th or 16th from ventralmost chaeta.

Septa x/xi to xv/xvi thickened.

Gizzard absent. No oesophageal glands. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, botryoidal. Prostates in xviii; compact and lobulate. No penial chaetae nor copulatory muscles. Spermathecae in vii, viii, ix; large sub-spherical sac with short thick duct; two small ovoidal diverticula open into spermathecal duct. (Fig. 334.)

Nephridia with small swollen vesicles.

Type Locality: Auckland Islands; W. B. Benham, 1909.

Type material in Otago Museum (No. A.56.29); 4 specimens and fragments, well preserved.

Previous Records:

Auckland Islands: (1) Magnetic Station, Camp Cove; (2) North arm, Carnley Harbour; (3) Magnetic station, Musgrave harbour; (4) Masked Island, Carnley Harbour, among the roots of *Stilbocarpa polaris*; (5) Adam's Island, at roots of *Pleurophyllum*, Fairchild's garden; (6) 2,000 ft., under stones; (7) Disappointment Island. (All records from Benham (1909)).

Perionyx shoeanus Cognetti de Martiis. Fig. 335

1912 *Perionyx shoeanus* Cognetti de Martiis, Ann. Mag. nat. Hist., ser 8, 9:67–9.

Length 165 mm. Diameter 5–6 mm. 205 segments.

Colour brown with dark purplish brown clitellum.

Clitellum xiii–xix (or xx), complete on xiv–xvii, elsewhere dorsal and lateral.

Prostomium epilobous.

Chaetae c.48/segment, not paired.

Male pores on xviii in line with chaeta a, not on papillae.

Female pores on xiv, close to ventral mid line, anterior to chaetae.

Spermathecal pores at 6/7, 7/8, 8/9, in line with chaetal interval ab.

Nephridiopores lateral, in more or less straight line, only slightly anterior to the chaetae, lateral.

Septa vi/vii to xv/xvi thickened.

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Gizzard in vi, small. No definite oesophageal glands but oesophagus in viii–xv wider than elsewhere and has many deep longitudinal folds. Intestine commences in xvii.

Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii.

Testes and funnels in x, xi, separated from main coelomic cavity by a horizontal mesentery. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose; those of ix smaller than those of xii. Prostates short tongue-shaped organs, projecting laterally through xviii, surrounded by thin sheath and each consisting of a number of distinct lobes. No penial chaetae nor copulatory muscles. Spermathecae in vii, viii, ix; ovoidal sac with slender duct (Cognetti states that the duct is very short, but I find that it enters the body wall about half way along the length of the segment, curves at a sharp angle and extends forward to the external pore at the anterior margin of the segment); two small pyriform diverticula open into spermathecal duct close to its entry into body wall. (Fig. 335).

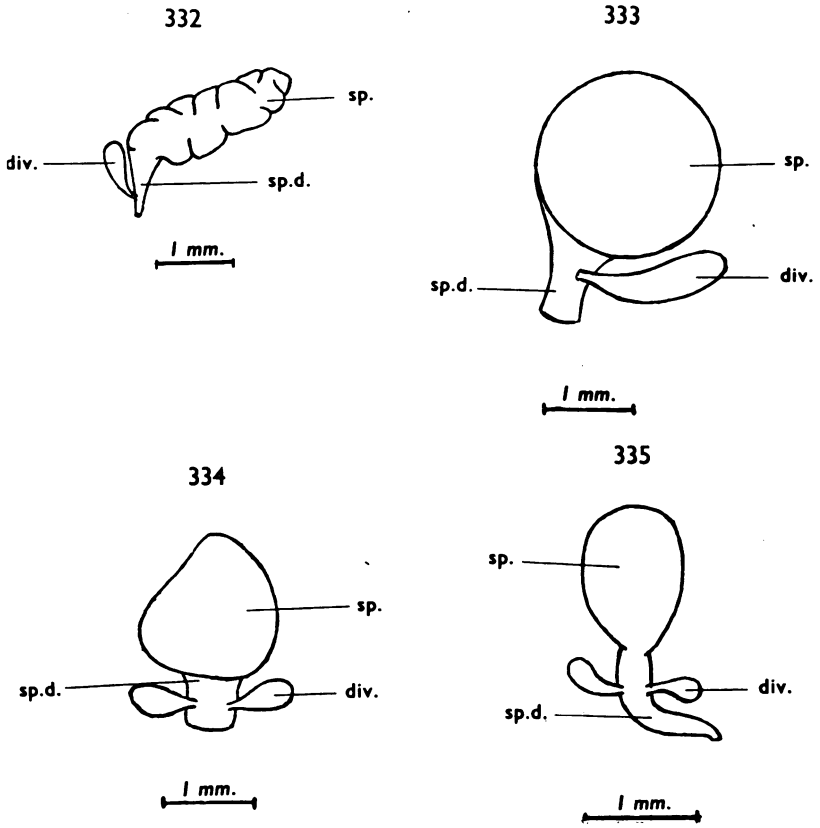

FIG. 332. *Perionyx egmonti.* Right posterior spermatheca, medial aspect
FIG. 333. *Perionyx helophilus.* Spermatheca (After Benham, 1909)
FIG. 334. *Perionyx perionychopsis.* Spermatheca. (After Benham, 1909)
FIG. 335. *Perionyx shoeanus.* Left spermatheca of viii, lateral aspect

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Nephridial vesicles absent.

Type Locality: Shoe Island, Port Ross, Auckland Is.; L. Cognetti de Martiis, 1912.

The type material of this species has not been located.

Localities:

Auckland Islands: Near Derry Castle Reef, Enderby Id.; under stones and logs; R. K. Dell, 17/3/54; 2 specimens. Rose Id., Port Ross; under logs; R. K. Dell, 19/3/54; 1 specimen.

Genus PHERETIMA Kinberg

1866 *Amynthas, Amyntas* + *Nitocris* + *Pheretima* + *Rhodopis* + *Perichaeta* Kinberg, Öfvers. VetenskAkad. Förh. Stockh. 23:97, 101, 102.
1883 *Megascolex* (part) + *Perichaeta* (part), Beddard, Ann. Mag. nat. Hist., ser. 5, 12:214.
1895 *Perichaeta* (part) + *Megascolex* (part), Beddard, Monograph pp. 388, 370.
1899 *Amyntas,* Michaelsen, Mitt. zool. Mus. Hamburg, 16:3.
1900 *Pheretima* (part), Michaelsen, Tierreich 10:234.
1900 *Amyntas,* Beddard, Proc. zool. Soc. Lond., 1900, p. 613.
1907 *Pheretima,* Michaelsen, Fauna Südwest-Aust. 1 (2): 164.
1922 *Promegascolex,* Cognetti de Martiis, Boll. Mus. Zool. Anat. comp. Torino, 37:3.
1923 *Pheretima,* Stephenson, Fauna Brit. India, Oligochaeta, p. 288.
1928 *Pheretima,* Michaelsen, Ark. Zool. 20A (3):4.
1930 *Pheretima* + *Megascolex* (part), Stephenson, Oligochaeta pp. 837–8.
1937 *Pheretima,* Gates, Rec. Indian Mus. 39:187.
1952 *Pheretima,* Lee, Trans. roy. Soc. N.Z. 80:39.

Some 350 species in this genus have been recorded, their descriptions are widely scattered in the scientific literature of the world, and I have had access to only a small proportion of the descriptions. No review of the genus has been published for many years, and until such a review is published it will be difficult to identify species of the genus. Only one species is known from New Zealand, and it is undoubtedly not endemic.

The following definition of *Pheretima* is that of Gates (1937b).

Chaetae perichaetine. One gizzard in viii; although the gizzard is in viii, in all the species in which septum viii/ix is present one or more of septa viii/ix to x/xi may be lacking or rudimentary so that the gizzard has the appearance of extending posteriorly. Micronephric. Testes and male funnels in testis sacs. Prostates racemose.

A large proportion of the species of *Pheretima* are characterised as follows: The chaetae begin on ii on which segment there is a complete chaetal circle. The clitellum is annular, extending over xiv–xvi; with development of clitellar glandularity the chaetae of the clitellar segments drop out and are not replaced, the intersegmental furrows 14/15 and 15/16 disappear and the dorsal pores are occluded. Spermathecal and male pores paired; a single female pore. Septa viii/ix–ix/x lacking, rudimentary or not normal. Intestine commences in xv or xvi, close to xv/xvi. Last pair of hearts in xiii, all hearts of ix–xiii opening into ventral blood vessel. Seminal vesicles paired in xi, xii, those of xi excluded from the testis sacs. Spermathecal diverticulum passing into the duct just at, close to, or within the parietes.

Type species: *P. californica* Kinberg. California, U.S.A.

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Number of Species: About three hundred and fifty have been described.

Distribution: Indo-Malaya; eastern Asia; Australia; a number of species are peregrine and have a world-wide distribution.

The following is a description of the species from New Zealand, which I have identified as *P. peregrina* (Fletcher).

Pheretima peregrina (Fletcher). Fig. 336

1886 *Perichaeta peregrina* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 1:969–71.
1900 *Pheretima peregrina,* Michaelsen, Tierreich 10:293.
1947 *Pheretima clerica,* Benham, Trans. roy. Soc. N.Z. 76:423–8.
1952 *Pheretima clerica,* Lee, Trans. roy. Soc. N.Z. 80:39–41.
1952 *Pheretima campestris,* Lee (Not *P. campestris* Goto and Hatai (1898)), Trans. roy. Soc. N.Z. 80:39–41.
1953 *Pheretima campestris,* Lee, Trans. roy. Soc. N.Z. 81:49.

This is a species which, unfortunately, has been greatly confused in New Zealand. Benham (1947) described a species, *P. clerica,* and in 1952 I described a species, *P. campestris,* which I considered to be distinct from *P. clerica.* I have since re-examined specimens and have collected and examined specimens from Benham's type locality for *P. clerica.* I have come to the conclusion that my *P. campestris* and Benham's *P. clerica* are identical, and, in addition, that the species is in fact *P. peregrina.* Furthermore the name *P. campestris* has previously been used (by Goto and Hatai (1898)) for a species from Japan, with which the present species has no connection.

Length 140–150 mm. Diameter 5 mm. 100–110 segments.

Colour brown with irridescent sheen, clitellum pale brown.

Clitellum xiv–xvi, complete.

Prostomium epilobous.

Chaetae c.36–48/segment, evenly spaced.

Male pores on xviii; transverse slit-like apertures in oval raised areas.

Female pores unpaired, median ventral, in small oval depression (Fletcher, 1886b, states that there is a pair of female pores, close together).

Spermathecal pores at extreme anterior margins of vi, vii, viii, ix, ventro-lateral.

Pharynx in i–iv. Gizzard posterior to vii/viii; septa viii/ix and ix/x are absent, the gizzard occupying a space corresponding to viii, ix and part of x. Oesophagus slightly dilated, but not forming distinct glands, in xi, xii. Intestine commences in xv or xvi; small ventral cornuiform diverticula in xxvi–xxiv.

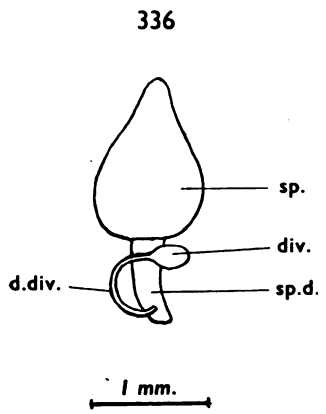

FIG. 336. *Pheretima peregrina.* Left posterior spermatheca, anterior aspect

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Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi in testis sacs. Ovaries in xiii. Vesiculae seminales in xi, xii, sac-like, irregularly lobed. Prostates in xviii, somewhat square and lobulate; occasionally the prostates are entirely absent, only the ducts being visible. Spermathecae in vi, vii, viii, ix; conical sac with duct about same length as sac; small globular diverticulum opening by long slender duct into anterior aspect of spermathecal duct. (Fig. 336).

Micronephridia in a narrow lateral band on peritoneum of each segment except i.

Type Locality: Sydney, Australia; J. J. Fletcher, 1886.

Localities:

North Island: Awanui; topsoil, pasture; K.E.L., 28/3/49; 2 specimens. Victoria Valley, Kaitaia; topsoil, pasture; K.E.L., 28/3/49; 2 specimens. Rangiahua; topsoil, pasture; O. Perry, 1/12/53; 2 specimens. Matangi; topsoil, pasture; R. L. Nielson, 21/4/53; 2 specimens. Tirau; topsoil, pasture; R. L. Nielson, 1953; 5 specimens. Tauranga; topsoil, pasture, R. L. Nielson, 5/12/53; 1 specimen. Te Araroa; topsoil, manuka scrub; R. L. Nielson, 8/49; 25 specimens.
Raoul Island: Topsoil, garden; A. C. S. Wright, 3/49; 14 specimens.

Previous Records:

North Island: Te Araroa; topsoil, pasture; W. B. Benham, 1947.

Genus PLUTELLUS Perrier

1873 *Plutellus* Perrier, Arch. Zool. exp. gén. 2:250.
1887 *Cryptodrilus* (part), Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 2:381.
1887 *Notoscolex* (part), Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 2:607.
1892 *Cryptodrilus* (part) + *Megascolides* (part), Spencer, Proc. roy. Soc. Vict. 4:132, 144.
1893 *Argilophilus* Eisen, Zoe, 4:252.
1900 *Plutellus* + *Argilophilus,* Eisen, Proc. Calif. Acad. Sci., ser. 3, 2:162.
1900 *Plutellus* + *Fletcherodrilus,* Michaelsen, Tierreich 10:163, 178.
1907 *Plutellus* + *Fletcherodrilus,* Michaelsen, Fauna Südwest-Aust. 1 (2): 159.
1909 *Plutellus* + *Fletcherodrilus,* Michaelsen, Mem. Indian Mus. 1:118–20.
1910 *Plutellus,* Michaelsen, Abh. naturw. Ver. Hamb. 19:22.
1922 *Plutellus* (*Plutellus*), Michaelsen, Capita zool. 1 (3):16.
1923 *Plutellus,* Stephenson, Fauna Brit. India, Oligochaeta, p. 170.
1928 *Plutellus* (*Plutellus*), Michaelsen, Handb. Zool. Berl., 2:116.
1930 *Plutellus,* Stephenson, Oligochaeta p. 833.
1952 *Plutellus,* Lee, Trans. roy. Soc. N.Z. 80:25.

There are over seventy species of this genus, of which only three are known from the New Zealand region. The following is a description based on that of Stephenson (1930).

Chaetae eight per segment. Male pores on xviii, paired or single; female pores on xiv, mostly paired; spermathecal pores end at furrow 8/9 or on segment ix, a single pair or a series of two to five pairs, or five single pores. A gizzard in the region of segments v–vii. Purely meganephridial. Prostates one pair, tubular, with simple unbranched canal.

Type species: *Plutellus heteroporus* Perrier. Pennsylvania, U.S.A.

Number of Species: About seventy-five.

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Distribution: India; Ceylon; Australia; New Caledonia; North America; New Zealand. Within the New Zealand region sporadically distributed in the South Island, Stewart Island and Auckland Islands. (Fig. 367).

The differences between this genus and *Pontodrilus,* to which it is closely related, are discussed under the latter genus.

KEY TO THE NEW ZEALAND SPECIES OF PLUTELLUS

a_1 Spermathecal pores two pairs, at 7/8, 8/9
  b_1 Last pair of hearts in xii; vesiculae seminales two pairs, in ix, xii ..... **P. aucklandicus**
  b_2 Last pair of hearts in xiii; vesiculae seminales two pairs, in xi, xii ..... **P. stewartensis**
a_2 Spermathecal pores four pairs, near anterior margins of vi, vii, viii, ix; last pair of hearts in xiii; vesiculae seminales two pairs, in ix, xii ..... **P. parvus**

The genus *Plutellus* has a sporadic distribution within the New Zealand region. Two species are known from the mainland, *P. parvus* from the South Island and *P. stewartensis* from Stewart Island, and one species, *P. aucklandicus,* from the Auckland Islands. There are considerable differences between the three species, but in their anatomy *P. aucklandicus* and *P. stewartensis* resemble each other more closely than either resembles *P. parvus* (see Table 18).

P. parvus resembles *Pontodrilus lacustris* more closely than it does either of the other two New Zealand species of *Plutellus.* The two genera *Pontodrilus* and *Plutellus* are distinguished principally by the reduction of the gizzard in the former, and its presence, usually well developed, in the latter. The gizzard of *Plutellus parvus* is small, narrow, and poorly developed. Benham, in his original description of *Pontodrilus lacustris,* states that though it had no gizzard, nor nephridia in the first fourteen segments, and might be considered as belonging to the genus *Pontodrilus,* in other respects it more closely resembled *Plutellus,* and he placed the species in *Plutellus.* Michaelsen (1907) removed the species from *Plutellus* to *Pontodrilus* where, strictly according to generic definitions, it should go, but its strong resemblances to *Plutellus parvus* are worthy of note, since it is difficult to conceive how a species of a littoral genus could have become established in a mountain lake, formed in a glaciated valley and far removed from the ocean.

Plutellus aucklandicus Benham. Fig. 337

1909 *Plutellus aucklandicus* Benham, Subant. Is. N.Z. 1:278–80.
1923 *Plutellus aucklandicus,* Michaelsen, Videnskab. Medd. dansk. naturh. Foren. Kbh. 75:226–7.
1952 *Plutellus aucklandicus,* Lee, Trans. roy. Soc. N.Z. 80:25.

Length 100–125 mm. Diameter 4–5 mm. 126–130 segments; preclitellar segments bi- or triannulate; post-clitellar segments biannulate.

Colour white with orange-brown clitellum.

Clitellum xiii–xviii, complete.

Prostomium epilobous.

Chaetae 8/segment: bc=cd>ab; dd>aa>bc.

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TABLE 18. Plutellus

——	*aucklandicus*	*parvus*	*stewartensis*
Length	100–125 mm.	32 mm.	78 mm.
Diameter	4–5 mm.	2 mm.	2·25 mm.
Segments	126–130	76	165
Colour	white	orange-brown	almost colourless
Clitellum	xiii–xviii	xiv–xvii	½xiii–xvii
Extent of clitellum ..	complete	dorsal and lateral	complete
Prostomium	epilobous	epilobous	epilobous
Male papillae	small, rounded	large, flat	small, rounded
Position of male pores ..	b	a	a/b
Position of female pores	anterior to a	antero-medial to a	anterior to b
Position of spermathecal pores	7/8, 8/9 a	anterior margins of vi, vii, viii, ix. a	7/8, 8/9 a
Position of nephridiopores	b	c	c
Septal thickening ..	ix/x–xiv/xv	absent	absent
Proventriculus ..	v	absent	v
Gizzard	vi	v	vi
Nature of gizzard ..	strong	narrow, poorly developed	long, strong
Oesophageal glands ..	xv	xiii	absent
1st intestinal segment ..	xviii	xv	xx
Dorsal blood vessel ..	unpaired	unpaired	unpaired
Hearts (pairs)	3	4	4
Last heart	xii	xiii	xiii
Origin of hearts ..	dorsal b.v.	supra-intest. b.v.	dorsal b.v.
Testes	x, xi	x, xi	x, xi
Vesiculae seminales ..	ix, xii lobed sac	ix, xii lobed sac	xi, xii racemose
Prostates	xviii	xviii–xix	xviii–xx
Penial chaetae.. ..	present (?)	present	absent
Copulatory muscles ..	present (?)	absent	absent
Spermathecae ..	viii, ix	vi, vii, viii, ix	viii, ix
Spermathecal diverticula			
Number	1	1	1
Form	small, globular	slender, tubular	tubular, spirally curved
Position	medial	medial	posterior
Nephridial vesicles ..	absent	absent	present

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Male pores on xviii, on small papillae, in line with chaeta b.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores in line with chaeta b.

Septa ix/x to xiv/xv thickened.

Proventriculus in v, wide, thin walled. Gizzard in vi, strong.

Oesophagus dilated in xi, xii, xiii, xiv, oesophageal glands in xv. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii, large, projecting upwards over the oesophagus; the strings of ova occupy the whole coelomic cavity of the segment. Vesiculae seminales in ix, xii, lobulated, sac-like. Prostates in xviii, tubular, compactly convoluted. (Benham states that penial chaetae and copulatory muscles are present. I have re-examined Benham's type material and other specimens, both in my own collection and in Benham's collection and have been unable to find these structures.) Spermathecae in viii, ix; pyriform sac with long duct; small pyriform diverticulum opens into spermathecal duct. (Fig. 337).

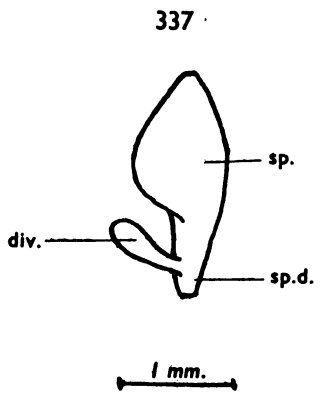

FIG. 337. *Plutellus aucklandicus.* Left posterior spermatheca, lateral aspect

Nephridial vesicles absent.

Type Locality: Auckland Islands; W. B. Benham, 1909.

Type (?) material in Otago Museum (No. A.07.10); 4 specimens, in good condition.

Localities:

Auckland Islands: Lookout Hill; Port Ross; peat, scrub; M. L. Leamy, 11/54; 2 specimens + fragments.

Previous Records:

Auckland Islands: (1) Adams Island, among roots of *Pleurophyllum* in Fairchild's garden; (2) Adams Id., 1,350 ft.; (3) Port Ross; (4) 200 ft. above the watering creek, at Camp Cove. (All records from Benham (1909)).

Plutellus parvus n.sp. Figs. 338–341

Length 32 mm. Diameter 2 mm. 76 segments.

Colour orange-brown (in alcohol).

Clitellum xiv–xvii, dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: aa=bc>ab; dd>cd>bc.

Male pores on xviii, on large, white, flat papillae, in line with chaeta a.

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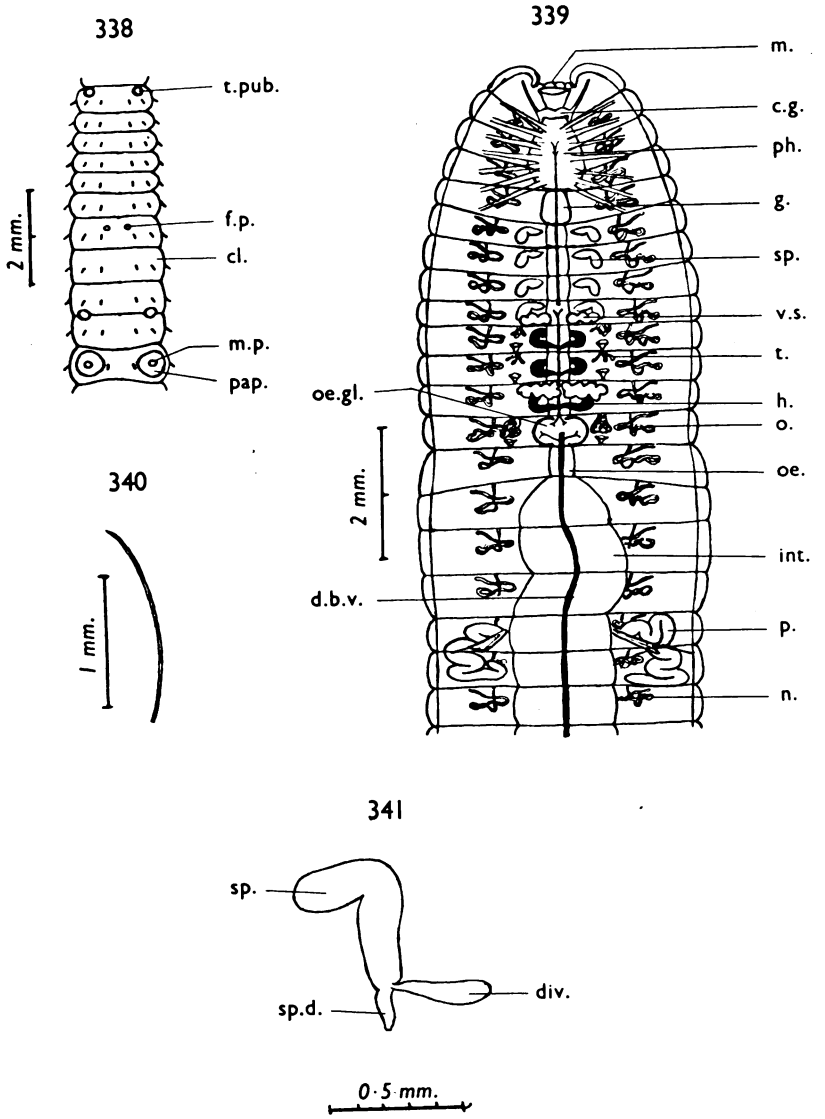
Female pores on xiv, anterior and slightly medial to chaeta a. Spermathecal pores at anterior margins of vi, vii, viii, ix, in line with chaeta a.

Nephridiopores in line with chaeta c.

Small, round, paired tubercula pubertatis, on vii anterior to chaeta b, at 16/17 in line with chaeta b.



FIGS. 338–341. *Plutellus parvus* n.sp.
338. Ventral aspect, segments viii–xviii
339. Dissection from dorsal aspect, segments i–xx
340. Penial chaeta
341. Right posterior spermatheca, anterior aspect

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No specially thickened septa.

Pharynx in i–iv, small and rounded. Gizzard in v, narrow, poorly developed. Oesophageal glands in xiii. Intestine commences in xv.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in ix–xiii. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, each consisting of a number of small digitate processes. Ovaries in xiii, each consisting of a number of moniliform threads attached to a thin membranous sheet. Vesiculae seminales in ix, xii, lobed, sac-like organs, those of ix much smaller than those of xii. Prostates in xviii–xix, tubular, convoluted. Penial chaetae present; very slender, gently curved, sharply pointed spine without ornamentation on the shaft (Fig. 340). Spermathecae in vi, vii, viii, ix; long slender sac, sharply curved in an "L"-shape, with short wide duct; slender diverticulum arises medially from spermatheca at junction of duct and sac. (Fig. 341).

Nephridial vesicles absent.

Type Locality: Akaroa; leaf mould, forest; R. R. Forster, 14/10/49.

Type specimen in Canterbury Museum collection.

Localities:

South Island: Same data as type material; 21 specimens. Hickory Bay, Akaroa; leaf mould, forest; R. Pilgrim, 26/1/52; 7 specimens. Chaselands; leaf mould, forest; R. R. Forster, 7/1/50; 10 specimens.

Plutellus stewartensis n.sp. Figs. 342–344

Length 78 mm. Diameter 2·25 mm. 165 segments.

Colour: almost colourless except for pale yellowish brown clitellum.

Clitellum ½xiii–xvii, complete.

Prostomium epilobous.

Chaetae 8/segment: cd>ab; dd>bc>aa⋙cd.

Male pores on small, round, white papillae, on xviii, in line with chaetal interval ab.

Female pores on xiv, slightly anterior to chaeta b.

Spermathecal pores at 7/8, 8/9, in line with chaeta a.

Nephridiopores in line with chaeta c.

Four prominent, unpaired, median ventral tubercula pubertatis; oval, transverse pads, on the posterior margins of x, xi, xii, and on xx, extending across the segments from chaeta a to chaeta a.

No specially thickened septa.

Pharynx in i–iv. Proventriculus in v, short, wide, thin walled. Gizzard in vi, long thick walled, strongly muscular. Oesophageal glands absent. Intestine commences in xx; markedly constricted at intersegmental septa and dilated in segments.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xviii–xx, tubular, convoluted. Penial chaetae and copulatory muscles absent. Spermathecae in viii, ix; cylindrical sac

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bent in U-shape, with narrow duct; tubular diverticulum, spirally curved, opens posteriorly into spermatheca, at junction of sac and duct. (Fig. 344).

Nephridia commence in ii; have very small, dilated vesicles.

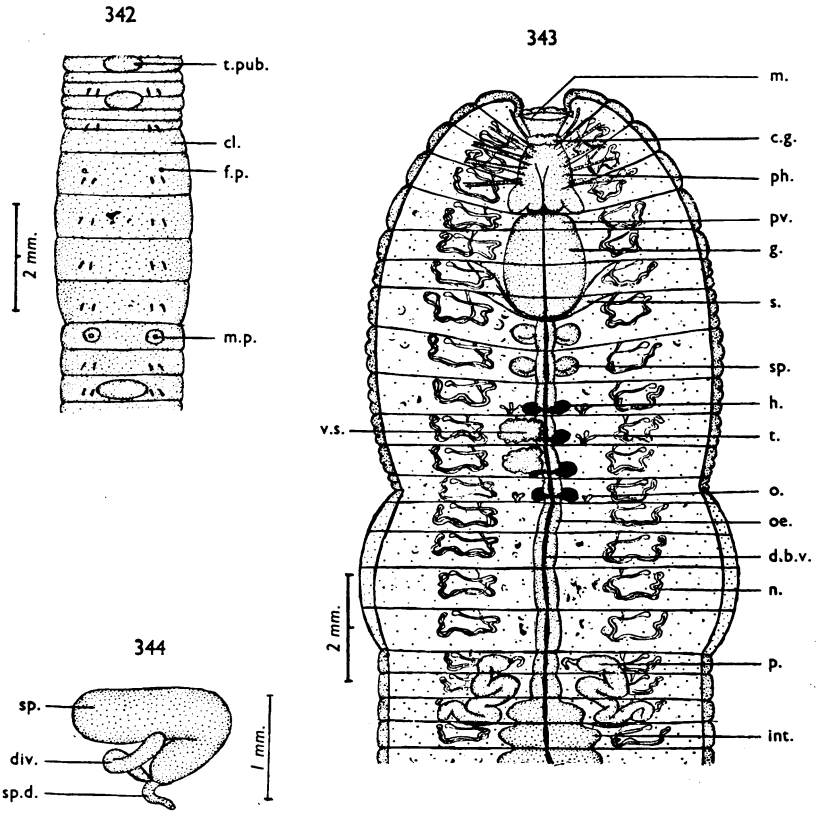
Type Locality: Top of Table Hill, Stewart Island, 2,340 ft.; peat bog; A. C. S. Wright, 12/50.

Type specimen in Soil Bureau collection.

Localities:

South Island: Orepuki; leaf mould, beech forest; R. R. Forster, 9/5/49; 10 specimens.

Stewart Island: Same data as type material; 4 specimens. Rocky Hill, near Freshwater R., 200 ft.; topsoil, beech forest; A. C. S. Wright, 12/50; 5 specimens. Mt. Rakeahua; leaf mould, beech forest; E. W. Dawson, 30/1/51; 6 specimens. Halfmoon Bay; leaf mould, beech forest; G. A. Knox, 10/1/51; 63 specimens. Ulva; leaf mould, beech forest; G. A. Knox, 12/1/51; 2 specimens. Rabbit Id., Paterson Inlet; peat, beech forest; A. C. S. Wright, 12/50; 8 specimens.



FIGS. 342–344. *Plutellus stewartensis* n.sp.
342. Ventral aspect, segments xii–xx
343. Dissection from dorsal aspect, segments i–xxi
344. Right anterior spermatheca, ventro-lateral aspect

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Genus PONTODRILUS Perrier

1874 *Pontodrilus* Perrier, C. R. Acad. Sci., Paris, 78:1582.
1891 *Cryptodrilus* (part), Rosa, Ann. naturh. (Mus.) Hofmus., Wien, 6:387.
1895 *Pontodrilus* (part), Beddard, Monograph p. 468.
1900 *Pontodrilus,* Michaelsen, Tierreich 10:179.
1910 *Pontodrilus,* Michaelsen, Mitt. zool. Mus. Hamb. 27:83.
1922 *Plutellus* subgen. *Pontodrilus,* Michaelsen, Capita zool. 1 (3):22.
1923 *Pontodrilus,* Stephenson, Fauna Brit. India, Oligochaeta, p. 179.
1928 *Plutellus* subgen. *Pontodrilus,* Michaelsen, Handb. Zool., Berl., 2:116.
1930 *Pontodrilus,* Stephenson, Oligochaeta p. 833.
1952 *Pontodrilus,* Lee, Trans. roy. Soc. N.Z. 80:25.

Chaetae eight per segment. Male pores one pair, on xviii, combined with prostatic pores, not always on papillae. Female pores one pair, on xiv, ventro-lateral. Spermathecal pores two to four pairs, the last pair anterior to 9/10. Nephridiopores in a single lateral series on each side of body. Gizzard frequently absent, if present very small, in v. Last pair of hearts in xii or xiii. Testes two pairs, in x, xi, not in testis sacs. Prostates one pair, with ducts opening to exterior in xviii, tubular. Penial chaetae sometimes present. Spermathecae two to four pairs, the last in ix. Nephridia absent anteriorly, commencing in the vicinity of the clitellum.

Type species: *Pontodrilus litoralis* (Grube) (= *P. marionis* Perrier). Southern France, shoreline of Mediterranean.

Number of Species: Five.

Distribution: Ceylon (*P. agnesae*); on the shores of many islands and countries of the Southern Hemisphere, North America, Southern Asia, Mediterranean; New Zealand (*P. lacustris* and *P. matsushimensis*).

Pontodrilus is distinguished from the closely related genus *Plutellus* by the absence of nephridia in front of the clitellum and by its "sculptured" chaetae. The absence of a gizzard in *Pontodrilus* and its presence in *Plutellus* was formerly used to distinguish the genera, but it has been found that in *Plutellus* (e.g. in *P. parvus*) the gizzard may be small and weakly developed, while in some species of *Pontodrilus* (e.g. *P. matsushimensis*) there is a small, weakly developed gizzard. The degree of development of the gizzard cannot therefore be given any significance and the distinction of the genera rests on little evidence.

Five species have been referred to *Pontodrilus.* Of these, *P. bermudensis, P. litoralis,* and *P. matsushimensis* are littoral, *P. lacustris* is lacustrine, and *P. agnesae* is terrestrial. In the aquatic species the absence of nephridia in some segments could be an adaptation to the aquatic environment, since in other aquatic families of Oligochaeta, e.g. Phreodrilidae, Tubificidae, it is common to find that there are no nephridia in some anterior segments. However, the one terrestrial species of the genus also lacks nephridia in the first twelve segments. Were it not for this species I would regard the species now included in *Pontodrilus* as species of *Plutellus* that have become adapted to an aquatic environment.

Michaelsen (1922a, 1928a) included *Pontodrilus,* as a subgenus, in the genus *Plutellus.* Stephenson (1930) retained the two genera.

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TABLE 19. Pontodrilus

——	*lacustris*	*matsushimensis* var. *chathamianus*
Length	35–40 mm.	75–125 mm.
Diameter	1·25 mm.	4·5 mm.
Segments	85–90	80–130
Colour	greyish, translucent	pale buff
Clitellum	½xiii–xvi	(½xiii) xiv–xvii (½xviii)
Extent of clitellum	complete	dorsal and lateral
Prostomium	prolobous	epilobous
Male papillae	absent	on medial aspects of longitudinal ridge
Position of male pores ..	b	ventro-lateral
Position of female pores ..	anterior to a	antero-medial to a
Position of spermathecal pores ..	anterior margins of vi, vii, viii, ix	7/8, 8/9, on papillae b
Position of nephridiopores ..	b	b
Septal thickening	viii/ix–xi/xii	vi/vii–xi/xii
Proventriculus	absent	absent
Gizzard	absent	v
Nature of gizzard	..	small
Oesophageal glands	absent	absent
1st intestinal segment ..	xviii	xx
Dorsal blood vessel	unpaired	unpaired
Hearts (pairs)	3	2
Last heart	xii	xiii
Origin of hearts	dorsal b.v.	dorsal b.v.
Testes	x, xi	x, xi
Vesiculae seminales	ix, xi; x filled with loose sperms	xi, xii racemose
Prostates	xviii–xvii	xviii–xix
Penial chaetae	present	absent
Copulatory muscles	absent	absent
Spermathecae	vi, vii, viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	small, globular	tubular
Position	lateral	lateral
1st nephridia	xv or xvi	xiii

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Since my knowledge of *Plutellus* is confined to only a few species from the New Zealand region, a small proportion of the total included in the genus, the genera have not been combined, but it is doubtful whether they are distinct.

KEY TO THE NEW ZEALAND SPECIES OF PONTODRILUS

a$_1$ Spermathecal pores two pairs, at 7/8, 8/9; gizzard in v, small; vesiculae seminales two pairs, in xi, xii ... **P. matsushimensis** var. **chathamianus**

a$_2$ Spermathecal pores four pairs, at anterior margins of vi, vii, viii, ix; gizzard lacking; vesiculae seminales two pairs, in ix, xii ..... **P. lacustris**

I have already commented, in discussing the genus *Plutellus*, on the similarity between *P. lacustris* and *Plutellus parvus*. *Pontodrilus matsushimensis* var. *chathamianus* has, according to Benham (1901b) a small, but highly muscular gizzard, with thick walls. It has no nephridia in the first thirteen segments, but apart from this it is undoubtedly closely similar to *Plutellus aucklandicus* and *Plutellus stewartensis* (see Table 19).

Pontodrilus lacustris (Benham). Figs. 345–347

1903 *Plutellus lacustris* Benham, Proc. zool. Soc. Lond., 1903 (2), pp. 228–30.
1904 *Plutellus lacustris*, Benham, Trans. N.Z. Inst. 36:192–8.
1907 *Pontodrilus lacustris*, Michaelsen, Fauna Südwest-Aust. 1 (2):160.
1909 *Plutellus lacustris*, Benham, Subant. Is. N.Z. 1:280.
1910 *Pontodrilus lacustris*, Michaelsen, Mitt. zool. Mus. Hamb. 27:92–3.
1952 *Pontodrilus lacustris*, Lee, Trans. roy. Soc. N.Z. 80:25.

Length 35–40 mm. Diameter 1·25 mm. 85–90 segments; segments with secondary annulations.

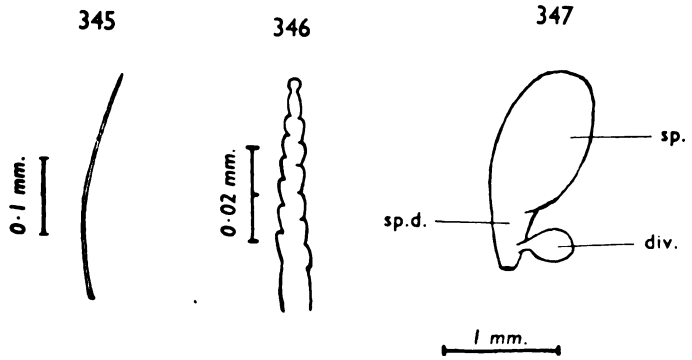
Colour greyish anteriorly, translucent posteriorly.

Clitellum ½xiii–xvi, complete.

Prostomium prolobous.

Chaetae 8/segment: aa=bc=cd>ab; dd>aa.

Male pores on xviii, not on papillae, in position of chaeta b.



FIGS. 345–347. *Pontodrilus lacustris*
345. Penial chaeta
346. Tip of penial chaeta
347. Spermatheca
(Drawings after Benham, 1903d)

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Female pores on xiv, anterior to chaeta a.

Spermathecal pores at anterior margins of vi, vii, viii, ix.

Nephridiopores in line with chaeta b.

Septa viii/ix to xi/xii thickened.

Gizzard absent. Oesophageal glands absent. Intestine commences in xviii.

Dorsal blood vessel unpaired. Hearts from dorsal blood vessel in x, xi, xii.

Testes in x, xi. Ovaries in xiii, very large; ovisacs in xiii.

Vesiculae seminales in ix, xi; coelomic cavity of x filled with loose mass of sperms. Prostates in xviii–xvii, tubular, convoluted. Penial chaetae in xviii; long, slender, gently curved, notched near distal end (Figs. 345, 346). Spermathecae in vi, vii, viii, ix; large ovoidal sac with short duct; small globular diverticulum opens into spermathecal duct laterally. (Fig. 347).

Meganephridia commence in xv or xvi; none in anterior segments.

Type Locality: Lake Wakatipu; free-swimming in lake water at depths of 300–1,200 ft.; W. B. Benham, 1903.

Type (?) material in Otago Museum (No. A.54.90); 15 specimens and fragments, preservation fair.

•

Pontodrilus matsushimensis var. **chathamianus** Michaelsen

1899 *Pontodrilus matsushimensis* var. *chathamianus* Michaelsen, Zool. Jahrb. Syst. 12:220.
1900 *Pontodrilus matsushimensis* var. *chathamiana,* Michaelsen, Tierreich 10:180.
1901 *Pontodrilus chathamensis,* Benham, Trans. N.Z. Inst. 33:129–44.
1910 *Pontodrilus matsushimensis* f. *chathamiana,* Michaelsen, Mitt. zool. Mus. Hamb. 27:91.
1952 *Pontodrilus matsushimensis* var. *chathamensis,* Lee, Trans. roy. Soc. N.Z. 80:25.

Length 75–125 mm. Diameter 4·5 mm. 80–130 segments, with secondary annulations; triannulate posteriorly, quinquiannulate anteriorly.

Colour pale buff, pink anteriorly, with brown clitellum.

Clitellum (½xiii)xiv–xvii(½xviii), dorsal and lateral.

Prostomium epilobous.

Chaetae 8/segment: ab=cd; dd>aa>bc>ab.

Male pores on xviii, each on the medial aspect of a longitudinal ridge, which overhangs a medial ventral depression.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, on small papillae, in line with chaeta b.

Nephridiopores in line with chaeta b, commencing on xiii.

Septa vi/vii to xi/xii thickened.

Gizzard in v, small. Oesophagus dilated in xiii, xiv, xv, but no definite glands. Intestine commences in xx.

Dorsal blood vessel unpaired. Seven pairs of lateral commissural vessels arise from the dorsal blood vessel, a pair in each of segments

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vii–xiii; those of xii and xiii are dilated and more conspicuous than the remainder, and are regarded as hearts.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in xi, xii, racemose. Prostates in xviii–xix, tubular, coiled and convoluted.

No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; globular sac with long duct; tubular diverticulum about half length of sac opens into duct close to body wall.

Nephridia commence in xiii; none in anterior portion of body.

Type Locality: Chatham Island; on shore; W. Michaelsen, 1899.

The type material was in the Hamburg Zoological Museum, but has been lost. Specimens of the variety are included in the collections of the Otago Museum.

Previous Records:

Chatham Island; on shore, W. B. Benham, 1901.

Remarks: Although originally collected from Japan, this littoral species is widely distributed on islands in the Pacific Ocean.

Genus SPENCERIELLA Michaelsen

1907 *Spenceriella* Michaelsen, Fauna Südwest-Aust. 1 (2) :161.
1923 *Spenceriella,* Stephenson, Fauna Brit. India, Oligochaeta p. 191.
1930 *Spenceriella,* Stephenson, Oligochaeta p. 835.
1952 *Spenceriella,* Lee, Trans. roy. Soc. N.Z. 80:37.

Chaetae very numerous (more than 50) on each segment. Clitellum developed over five to six segments, between xiii and xviii. Male pores one pair, on xviii, not always on papillae. Female pores one pair, on xiv, close to ventral mid line. Spermathecal pores two or three pairs, ventro-lateral, the last at 8/9. Some septa between gizzard and first intestinal segment thickened and muscular. Gizzard in v, large and well developed. Dorsal blood vessel usually unpaired, in one species (*S. gigantea*) paired in viii–xv; three or four pairs of hearts, the last pair in xii or xiii. Testes two pairs, in x, xi, those of x usually much smaller than those of xi. Prostates one pair, opening to exterior in xviii, tubular. No penial chaetae nor copulatory muscles. Spermathecae two or three pairs, the last in ix; each spermatheca has one or two diverticula, in the same segment as the sac. Micronephridia arranged in a band across the lateral aspects of the peritoneum.

Type species: *Spenceriella notabilis* (Spencer). Victoria, Australia.

Number of Species: Eight.

Distribution: Australia; South India; New Zealand, confined to northern districts of the North Island and neighbouring coastal islands (Fig. 366).

The genus was established by Michaelsen for some species which had been referred to *Diporochaeta.* They differ from *Diporochaeta* principally in being micronephridial, while *Diporochaeta* is meganephridial.

Michaelsen and Stephenson regarded the genus as having been derived from *Diporochaeta,* or from *Megascolides* by a change to the

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TABLE 20. Spenceriella

——	*argillae*	*gigantea*
Length	197 mm.	1300–1400 mm.
Diameter	7–8 mm.	11 mm.
Segments	153	c. 450
Colour	pink, translucent	red
Clitellum	xiii–xviii	xiii–½xviii
Extent of clitellum	dorsal and lateral	complete
Prostomium	prolobous	limits not recognizable
Chaetae/segment	60–72	c. 60
Male papillae	small, in small oval pits	absent; pores on transverse tuberculum
Position of male pores	c	c
Position of female pores	anterior to a	antero-medial to c
Position of spermathecal pores	7/8, 8/9 d	7/8, 8/9 f
Septal thickening	v/vi–xiii/xiv	vii/viii–xiii/xiv
Proventriculus	absent	absent
Gizzard	v	v
Nature of gizzard	long, strong	long, strong
Oesophageal glands	xiii–xiv	xii, xiii
1st intestinal segment	xvi	xvi
Dorsal blood vessel	unpaired	paired in viii–xv
Hearts (pairs)	4	3
Last heart	xiii	xii
Origin of hearts	supra-intest. b.v.	x supra-intest. v. xi, xii dorsal and supra-intest. vv.
Testes	x, xi	x, xi
Vesiculae seminales	xii racemose	xii racemose
Penial chaetae	absent	absent
Copulatory muscles	absent	absent
Spermathecae	viii, ix	viii, ix
Spermathecal diverticula:		
Number	1	1
Form	very small, spheroidal	small, pyriform
Position	posterior	lateral
Micronephridial	narrow lateral band	narrow lateral band

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TABLE 20. Spenceriella—*continued*

pallida	*shakespeari*
300 mm.	120 mm.
7 mm.	5 mm.
c. 280	195
greyish white	pale red
½xiii–½xviii	½xiii–xvii
complete	complete
zygolobous	epilobous
60–70	c. 50
small, in transverse depression	small, in small round pits
ventral	a/b
antero-medial to a	antero-medial to a
6/7, 7/8, 8/9	7/8, 8/9
ventral	c
v/vi–xiii/xiv	vi/vii–xi/xii
part v	absent
part v	v
long, strong	long, strong
xiii–xiv	xi, xii, xiii
xvi	xvi
unpaired	unpaired
4	4
xiii	xiii
dorsal b.v. and supra-intest. b.v.	supra-intest. b.v.
x, xi	x, xi
xii	ix, xii
racemose	racemose
absent	absent
absent	absent
vii, viii, ix	viii, ix
2	1
very small, globular	small, ovoidal
1 anterior	medial
1 posterior	
broad lateral band	narrow lateral band

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perichaetine condition. However, the genus is just as closely related to *Megascolex* as it is to either of these two genera.

KEY TO THE NEW ZEALAND SPECIES OF SPENCERIELLA

a_1 Spermathecal pores two pairs, at 7/8, 8/9
  b_1 Dorsal blood vessel paired in viii–xv only ..... **S. gigantea**
  b_2 Dorsal blood vessel unpaired throughout its length
    c_1 Oesophageal glands one pair, extending through xiii–xiv; vesiculae seminales one pair, in xii ..... **S. argillae**
    c_2 Oesophageal glands three pairs, in xi, xii, xiii; vesiculae seminales two pairs, in ix, xii ..... **S. shakespeari**
a_2 Spermathecal pores three pairs, at 6/7, 7/8, 8/9 ..... **S. pallida**

The four New Zealand species of *Spenceriella* are confined to the northern portion of the North Island and a few northern off-shore islands. *S. argillae, S. gigantea* and *S. pallida* are restricted to the North Auckland peninsula, while *S. shakespeari* is found from the North Auckland peninsula southwards down the western side of the North Island to about north Taranaki.

There are considerable superficial differences in the size, colour and general proportions of the four species, but in their internal anatomy there is a striking similarity (Table 20). *S. argillae* and *S. shakespeari* can only be distinguished by small details in their internal anatomy and they do not differ greatly from *S. gigantea. S. pallida* is readily distinguishable by its possession of three pairs of spermathecae, while the other species have two pairs. There is a tendency within the genus towards a reduction in the complexity of the male reproductive organs. Only one pair of vesiculae seminales is found in *S. argillae, S. gigantea* and *S. pallida,* and in *S. argillae* and *S. gigantea,* although there are two pairs of testes, those of x are much smaller than those of xi. Only *S. shakespeari* does not show any reduction in the male organs.

Spenceriella argillae n.sp. Figs. 348–350

Length 197 mm. Diameter 7–8 mm. 153 segments, all except i with secondary annulations; anterior to xviii segments have two to six annulations, remainder of segments quadriannulate.

Colour: body wall translucent in life, with red colour of blood showing through; opaque white in alcohol with pale brownish clitellum.

Clitellum xiii–xviii, dorsal and lateral.

Prostomium prolobous.

Chaetae 60–72/segment, closely and evenly spaced.

Male pores on small white papillae, each at the centre of a small oval depression, on xviii, in line with third from ventral-most chaeta. Six ventral-most chaetae on each side of xviii absent.

Female pores on xiv, anterior to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with fourth from ventral-most chaeta.

Large median ventral, oval tuberculum pubertatis at 16/17 and a pair of large tubercula with raised edges at posterior margin of xviii, posterior to the depressions containing the male pores.

Septa v/vi to xi/xii greatly thickened and muscular, xii/xiii and xiii/xiv slightly thickened.

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Pharynx in i–iv, pyriform, covered dorsally and laterally with masses of salivary glands, and has stout extrinsic muscles. Gizzard in v, elongate, thick walled, very muscular. Oesophageal glands one pair in xiii–xiv, large and prominent. Intestine commences in xvi.

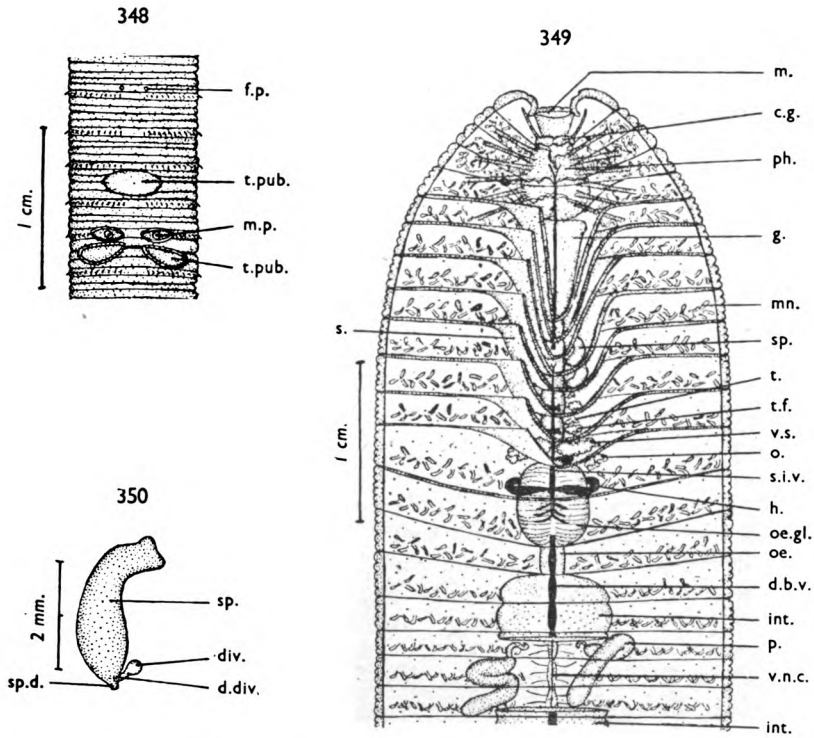
Dorsal blood vessel unpaired. Supra-intestinal vessel in viii–xiv. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi, the testes and funnels of x much smaller than those of xi. Ovaries in xiii. Vesiculae seminales in xii, racemose. Prostates in xviii–xx, tubular, slightly convoluted. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; long, cornuiform sac, curving upwards from very short duct; very small, spheroidal diverticulum opens by short, slender duct into posterior aspect of spermathecal duct. (Fig. 350).

Micronephridia commence in ii; in ii–iv very close set, forming thick mat over peritoneum; posterior to iv arranged in a single line across the ventro-lateral and lateral aspects of the peritoneum.

Type Locality: Near Ruakaka, S. of Whangarei; subsoil, manuka scrub and rushes; K.E.L., 24/7/51.

Type specimen in Soil Bureau collection.



FIGS. 348–350. *Spenceriella argillae* n.sp.
348. Ventral aspect, segments xiv–xix
349. Dissection from dorsal aspect, segments i–xx
350. Left anterior spermatheca, lateral aspect

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Localities:

North Island: Same data as type material; 6 specimens.

Spenceriella gigantea (Benham). Fig. 351

1906 *Diporochaeta gigantea* Benham, Trans. N.Z. Inst. 38:252–4.
1907 *Spenceriella gigantea*, Michaelsen, Fauna Südwest-Aust. 1 (2):161.
1949 *Diporochaeta gigantea*, Benham, Trans. roy. Soc. N.Z. 77:346.
1952 *Spenceriella gigantea*, Lee, Trans. roy. Soc. N.Z. 80:37.

Length 990 mm. (in alcohol); up to 1300–1400 mm. alive. Diameter 11 mm. c.450 segments.

Colour purplish red anteriorly on dorsal aspect, with purplish streak running right along dorsal mid line, elsewhere pale reddish when alive, white in alcohol.

Clitellum xiii–½xviii, complete.

Prostomium: limits not recognisable, due to extreme furrowing of peristomium; tanylobous or epilobous.

Chaetae c.60/segment, evenly spaced except for dorsal and ventral gaps.

Male pores one at each end of a transverse, oval, glandular area on xviii, in line with chaeta c.

Female pores on xiv, antero-medial to chaeta c.

Spermathecal pores at 7/8, 8/9, in line with chaeta f.

Septa vii/viii to xiii/xiv greatly thickened and muscular.

Gizzard in v, long, thick walled. Oesophagus dilated in xii, xiii, but no definite oesophageal glands. Intestine commences in xvi.

Dorsal blood vessel paired in viii–xv, otherwise unpaired. Unpaired supra-intestinal vessel present. Hearts in x, xi, xii; those of x from supra-intestinal vessel, those of xi, xii connected to dorsal and supra-intestinal vessels.

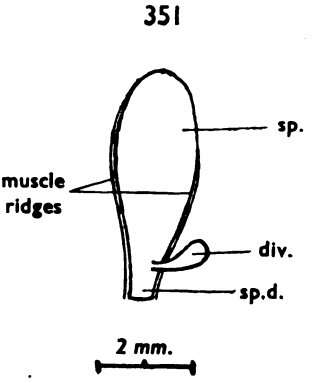

FIG. 351. *Spenceriella gigantea*. Spermatheca. (After Benham, 1906a)

Testes in x, xi; those of x smaller than those of xi and possibly functionless, since there is only one pair of vesiculae seminales, in xii (*S. argillae* is similar). Ovaries in xiii. Vesiculae seminales in xii, racemose. Prostates in xviii–xvi, tubular, extending straight forward. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; ovoidal sac with short duct not distinctly marked off from sac; small pyriform diverticulum opens into spermathecal duct; the sac has two narrow muscular ridges, one lateral and one medial, running down to body wall. (Fig. 351).

Micronephridia in dense mass on peritoneum in anterior segments; posterior to xviii they are limited to a narrow band across the ventro-

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lateral and lateral aspects of the peritoneum. Pair of large "meganephridial" funnels projects forward into each segment from the posterior septum.

Type Locality: Little Barrier Island; on plateau 600 ft. above sea level; subsoil, forest; W. B. Benham, 1905.

Type specimen in Otago Museum (No. A.06.92); 1 specimen, dissected, in good condition.

Localities:

North Island: Leigh; deep subsoil, broadleaved forest; K.E.L., 28/7/51; 1 specimen. Leigh; S. Wyatt, 3/11/51; 1 specimen. Whatoro, near Kaihu; A. Shephard, 8/49; 1 specimen. Tapuni; pine plantation; R. Robinson, 20/10/50; 1 specimen.

Little Barrier Island: Waipawa Stm. valley; subsoil, broadleaved forest; R. Dale, 28/8/52; 1 specimen. On log; J. S. Edwards, 5/54; 1 fragment.

Hen and Chicken Islands: Hen Id.; R. G. Turbott, 5/54; 1 specimen. Big Chick Id.; subsoil, scrub; M. Esson, 9/55; 3 specimens. Big Chick Id., topsoil, coastal scrub; M. Esson, 9/55; 1 specimen.

Spenceriella pallida n.sp. Figs. 352–354

Length 300 mm. Diameter 7 mm. c.280 segments; prostomium and first three segments longitudinally furrowed; ii–viii biannulate; ix–xviii triannulate; posterior to xviii quadriannulate.

Colour greyish white with narrow pink streak running along dorsal mid line.

Clitellum ½xiii–½xviii, complete.

Prostomium zygolobous.

Chaetae 60–70/segment, unpaired, closely and evenly spaced except for wider dorsal and ventral gaps.

On ventral surface of xviii is a shallow pit, 3·5 mm. wide and 1·5 mm. long in type specimen; floor of pit darkly pigmented and from it arise two small, white papillae, one on each side, close to posterior margin of pit; male pores on these papillae. There is a smaller darkly pigmented pit at 16/17, similar in appearance and position to that containing the male papillae.

Female pores 0·5 mm. from ventral mid line, in a transverse groove, medial to line of chaeta a.

Spermathecal pores at 6/7, 7/8, 8/9, 1·25 mm. from the ventral mid line.

Septa v/vi to xi/xii greatly thickened and muscular; septa xii/xiii and xiii/xiv slightly thickened and muscular; strong longitudinal muscle strands join the muscular septa.

Pharynx in i–iv, small, globular, covered with masses of salivary glands. Proventriculus in anterior portion of v, short, wide, thin walled. Gizzard occupies the remainder of v, long, strongly muscular, bell shaped, tapering posteriorly. Oesophageal glands one pair, in xiii–xiv. Intestine commences in xvi.

Dorsal blood vessel unpaired. Unpaired supra-intestinal vessel in viii–xiv. Hearts in x, xi, xii, xiii, connected to both dorsal and supra-intestinal blood vessels.

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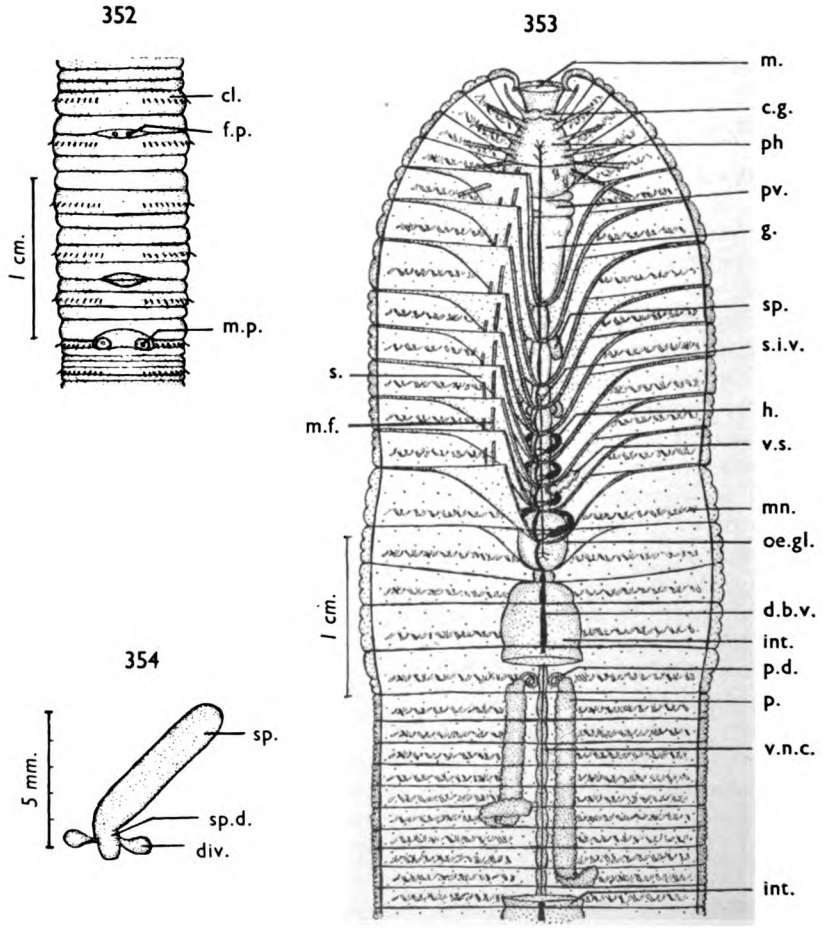
Testes and ovaries not visible, but funnels apparently corresponding to these organs are present in x, xi, and xiii. Vesiculae seminales in xii only (as in *S. gigantea* and *S. argillae*); this might be taken as an indication that there is only one functional pair of testes, but testes were not seen in any specimen. Prostates in xviii–xxiv (or sometimes xxvii); surface of gland raised in small, rounded pustules, but there is a single, central, unbranched canal. No penial chaetae nor copulatory muscles. Spermathecae three pairs, opening to the exterior from vii, viii, ix; elongate tubular sac opening to the exterior by short narrow duct and having two very small round diverticula opening by short narrow ducts into the spermathecal duct (Fig. 354); spermathecae of vii and ix are confined to one segment but the spermathecae of viii are longer and penetrate through viii/ix to lie beside the spermathecae



FIGS. 352–354. *Spenceriella pallida*. n.sp.
352. Ventral aspect, segments xiii–xix
353. Dissection from dorsal aspect, segments i–xxviii
354. Left anterior spermatheca, medial aspect

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of ix. Possibly the spermathecae of viii are functional and the others are not.

Micronephridia very numerous and close set, on ventro-lateral and lateral aspects of peritoneum.

Type Locality: Near Wellsford, Northland; subsoil, manuka scrub; K.E.L., 27/7/51.

Type specimen in Soil Bureau collection.

Localities:

North Island: Same data as type material; 8 specimens.

Spenceriella shakespeari (Benham). Fig. 355

1906 *Diporochaeta shakespeari* Benham, Trans. N.Z. Inst. 38:255–7.
1907 *Spenceriella shakespeari,* Michaelsen, Fauna Südwest-Aust. 1 (2):161.
1952 *Spenceriella shakespeari,* Lee, Trans. roy. Soc. N.Z. 80:37.

Length 120 mm. Diameter 5 mm. 195 segments.

Colour pale red with yellowish clitellum (alive); white with yellowish clitellum in alcohol.

Clitellum ½xiii–xvii, complete.

Prostomium epilobous.

Chaetae c.50/segment, closely and evenly spaced except for wide dorsal and ventral gaps.

Male genital area highly characteristic: male pores on small papillae rising from small round pits, on xviii, in line with chaetal interval ab; two prominent tubercula pubertatis, one near anterior margin of xvii, the other at 19/20, each an oval pad with prominent ridge surrounding central depression.

Female pores on xiv, antero-medial to chaeta a.

Spermathecal pores at 7/8, 8/9, in line with chaeta c.

Septa vi/vii to xi/xii thickened.

Gizzard in v, long, thick walled. Oesophageal glands in xi, xii, xiii. Intestine commences in xvi.

Dorsal blood vessel unpaired. Supra-intestinal vessel present. Hearts from supra-intestinal vessel in x, xi, xii, xiii.

Testes in x, xi. Ovaries in xiii. Vesiculae seminales in ix, xii, racemose. Prostates in xviii–xxiv, tubular, almost straight. No penial chaetae nor copulatory muscles. Spermathecae in viii, ix; slender ovoidal sac merging into short wide duct; small ovoidal diverticulum opens by short narrow duct into spermathecal duct. (Fig. 355). Micronephridia numerous; in genital region form a broad band across the ventro-lateral and lateral aspects of the peritoneum, elsewhere in narrow band.

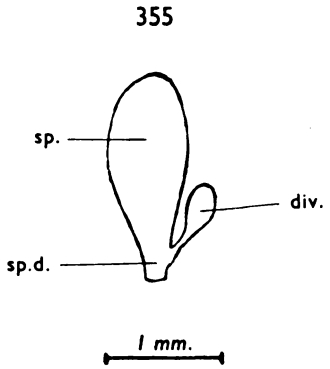

FIG. 355. *Spenceriella shakespeari.* Spermatheca. (After Benham, 1906a)

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Type Locality: Little Barrier Island; bank of stream in dense forest; W. B. Benham, 1906.

Type (?) material in Otago Museum (No. A.43.48); 6 specimens, in good condition.

Localities:

North Island: Leigh; topsoil, broadleaved forest; K.E.L., 28/7/51; 1 specimen. Warkworth; topsoil, broadleaved forest; K.E.L., 28/7/51; 3 specimens. Waiwera; topsoil, broadleaved forest; K.E.L., 28/7/51; 3 specimens. Muriwai; topsoil, broadleaved forest; K.E.L., 28/7/51; 11 specimens. 4 miles S. of Muriwai; topsoil, young kauri and scrub; K.E.L., 28/7/51; 4 specimens. Waitakere Ra.; topsoil, mixed podocarp-kauri forest; K.E.L., 29/7/51; 7 specimens. Anawhata Gorge, Waitakere Ra.; topsoil, coastal forest; J. S. Edwards, 24/5/52; 9 specimens. Pukekohe; topsoil, forest; W. Cottier 1951; 3 specimens. Waipa R. valley; topsoil, broadleaved forest; K.E.L., 17/5/50; 1 specimen. Whatawhata, W. Waikato; topsoil, broadleaved forest; K.E.L., 19/5/50; 12 specimens. Raglan Ra., W. Waikato; topsoil, broadleaved forest; K.E.L., 19/5/50; 1 specimen. Te Mata, near Raglan; topsoil, broadleaved forest; K.E.L., 21/5/50; 1 specimen. Mahoenui, S.W. Waikato; topsoil, podocarp-broadleaved forest; K.E.L., 26/5/50; 7 specimens. 10 miles S. of Ohura; topsoil, broadleaved forest; K.E.L., 13/5/50; 1 specimen.

Hen and Chicken Islands: Hen Id.; under stones and in topsoil; H. S. Fairburn, 8/53; 13 specimens. Big Chick Id.; topsoil, coastal scrub; M. Esson, 9/55; 1 specimen.

Little Barrier Island: Te Waikohare Ridge; topsoil, broadleaved forest; J. S. Edwards, 24/8/52; 2 specimens. Hingaia; under stones, coastal forest; J. S. Edwards, 26/8/52; 3 specimens. Pohutukawa Flat; under stones, coastal forest; J .S. Edwards, 27/8/52; 3 specimens. Waipawa Stm. valley; topsoil, broadleaved forest; J. S. Edwards, 29/8/52; 3 specimens.

INCERTAE SEDIS

Megascolex antarcticus Baird

1871 *Megascolex antarctica* Baird, Proc. Linn. Soc. Lond. 11:96.
1877 *Megasolex antarctica,* Hutton, Trans. N.Z. Inst. 9:350.
1887 *Perichaeta antarctica,* Beddard, Proc. R. phys. Soc. Edinb. 14:175.
1889 *Perichaeta antarctica,* Beddard, Proc. zool. Soc. Lond., 1889, p. 380.
1889 *Megascolex antarcticus,* Vaillant, Hist. nat. Annel. 3 (1):88.
1890 *Perichaeta antarctica,* Benham, Quart. J. micr. Sci. 31:236.
1891 *Perichaeta antarctica,* Beddard, Proc. R. phys. Soc. Edinb. 10:276.
1895 *Megascolex antarcticus* sp. inc. sed., Beddard, Monograph p. 369.
1900 *Megascolex antarcticus,* Michaelsen, Tierreich 10:233.
1901 *Megascolex antarcticus,* Benham, Trans. N.Z. Inst. 33:123.
1952 *Megascolex antarcticus,* Lee, Trans. roy. Soc. N.Z. 80:38.

The description given by Baird was very short and quite inadequate to identify the species. Only one specimen was obtained. The following is Baird's description:

"Body consisting of about 180 rings. Setae surrounding the body, short, black, rather distant. Rings not keeled; larger and more distinct at the anterior extremity, closer at the posterior end, and all smooth.

"Length 7 inches.

"Habitat: New Zealand."

Type specimen in British Museum (Nat. Hist.), Collection registration No. 1845.6.8.1.

Beddard (1887b) re-examined Baird's specimen. In addition to the characters listed by Baird he stated that "the 17th and 19th segments are each furnished with a single median genital papilla placed exactly in the centre of the segment, and therefore interrupting the line of

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setae." Beddard was unable to dissect the animal since there was only one specimen.

Megascolides orthostichon (Schmarda)

1861 *Hypogaeon orthostichon* Schmarda, Neue Wirbell. Thiere 1 (2) :12.
1883 *Lumbricus orthostichon,* Hutton, N.Z. J. Sci. 1:586.
1886 *Lumbricus orthostichon,* Fletcher, Proc. Linn. Soc. N.S.W., ser. 2, 1:524.
1891 *? Hypogaeon orthostichon,* Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1892 *Megascolides orthostichon,* Beddard, Ann. Mag. nat. Hist., 1892, p. 130.
1895 *Megascolides orthostichon,* Beddard, Monograph p. 496.
1900 *Notoscolex orthostichon,* Michaelsen, Tierreich 10:189.
1905 *Notoscolex orthostichon,* Ude, Z. wiss. Zool. 83.
1907 *Megascolides orthostichon,* Michaelsen, Die Fauna S.W. Aust. 1(2): 161.
1916 *Notoscolex orthostichon,* Michaelsen, K. svenska VetenskAkad. Handl. 52 (13).
1949 *"Hypogaeon orthostichon",* Benham, Trans. roy. Soc. N.Z. 77:350.

This species has not been recorded since it was first described by Schmarda (1861). The description given by Schmarda is insufficient for the identification of the species. The following summary is taken from the descriptions published by Beddard (1895) and Michaelsen (1900).

Length 180 mm. Diameter 4 mm. 65 segments.

Colour dark red.

Clitellum xiv–xvii, complete.

Chaetae 8/segment: ab=bc=cd.

Male pores on xviii, in line with chaeta a, not on papillae.

Spermathecal pores at 7/8, 8/9.

Gizzard in v.

Ovaries in xiii. Vesiculae seminales in x, xi, xii. Prostates in xviii, tubular, short. Spermathecae in viii, ix; pyriform sac; small pyriform diverticulum.

Micronephridial.

Type Locality: Mt. Wellington, New Zealand, L. K. Schmarda, 1861.

Remarks: There has been some discussion as to whether this species was actually collected from New Zealand or whether it might have been from Tasmania. There is a Mt. Wellington near Auckland, and the species may well have been collected from there.

Family **LUMBRICIDAE**

The following diagnosis is taken from Stephenson (1930, p. 905): "Chaetae sigmoid, simply pointed, often finely ornamented, eight per segment, in regular longitudinal rows. Dorsal pores present. Clitellum usually saddle shaped, beginning on a segment posterior to the male pores. Male pores usually on xv, rarely displaced one to four segments forward. Female pores usually on xiv. Frequently the chaetae on some anterior segments are situated on papillae and function as copulatory

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chaetae. Oesophagus with calciferous glands. Single well developed gizzard at beginning of intestine. Testes and funnels two pairs, in x, xi; no prostates projecting freely into body cavity, rarely prostate-like glandular cushions present. Ovaries in xiii. Spermathecae, if present, simple, without diverticula (often constricted by the septa in such a way that they appear to consist of two portions, sac and diverticulum). Meganephridial."

The family is not endemic in the New Zealand region, but a few species have been introduced by man and are very widely distributed.

GENERAL MORPHOLOGY

The classical text book "type earthworm", *Lumbricus terrestris,* may be taken as showing the general morphological features of Lumbricidae. Since detailed descriptions of its anatomy are available in elementary zoology text books, no description is necessary here. Species of Lumbricidae resemble one another so closely that for practical purposes, a description of one may readily be adapted to any other.

TAXONOMIC CHARACTERS

The characters used in the identification of genera and species of Lumbricidae differ widely from those used for Megascolecidae.

GENERIC CHARACTERS

Chaetae: In all genera there are eight chaetae on each segment except the first and last. The spacing of the chaetae, whether closely or widely paired, or in eight distinct lines, is of some assistance in recognising genera.

Spermathecal pores: In two genera, *Eisenia* and *Eiseniella,* the spermathecal pores are situated near the dorsal mid line, dorsal to chaeta d. In the remaining genera they are situated at the level of chaeta d or ventral to chaeta d.

Gizzard: The gizzard may occupy one segment or more than one. *Eiseniella* has the gizzard in one segment while in the remaining genera it extends through two or more segments.

Testis sacs: Two genera, *Lumbricus* and *Octolasium,* have the testes, their funnels and the openings of the vesiculae seminales in testis sacs, which are ventral and separated from the coelomic cavity of the testicular segments. The remaining genera have the testes and associated organs projecting freely into the coelom.

Vesiculae seminales: The number, position and form of the vesiculae seminales are used in defining genera. There may be two, three or four pairs, in x, xii or xi, xii or ix, x, xii, or ix, xi, xii or ix, x, xi, xii. There are size differences, anterior pairs frequently being smaller than posterior pairs, or (as in *Lumbricus*) the most posterior pair extends through two or more segments. In *Octolasium* the most posterior pair is multilobate while anterior vesiculae are simple pyriform organs.

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SPECIFIC CHARACTERS

Size: Size in itself is not a reliable taxonomic character, but can be used as a guide for distinguishing some species.

Colour: This is useful in some species, e.g. to distinguish *Allolobophora caliginosa* from *A. terrestris* at sight, but is highly variable in some species.

Clitellum: The position of the clitellum and the number of segments which it covers vary slightly for any species, but the limits of variation are small, and the clitellum therefore provides a useful specific character.

Dorsal pores: The first dorsal pore has a more or less constant position for each species.

Male pores: The male pores are usually situated on xv, but in some species are on other segments, e.g. in *Eiseniella* they are on xiii. The male pores of some species have very wide tumid lips, while in other species they are insignificant, e.g. *A. caliginosa* and *A. terrestris* may be distinguished on these grounds.

Tubercula pubertatis: These usually take the form of ventro-lateral longitudinal ridges, extending across several segments in the region of the clitellum. Sometimes they are divided into separate papillae by intersegmental furrows or are slightly constricted intersegmentally.

Septal thickening: A few of the septa anterior to the gizzard are thicker than normal in some species. This is a useful specific character.

Spermathecae: The number and position of the pairs of spermathecae is a useful distinguishing feature of species in some genera, e.g. the three species of *Allolobophora* which occur in New Zealand can be distinguished from this character.

THE NEW ZEALAND LUMBRICIDAE

Only fourteen species, belonging to seven genera, are known from the New Zealand region. Cernosvitov and Evans (1947) stated that the family includes about 220 species, belonging to eight genera. The natural distributional range of the family comprises the temperate and cold regions of the northern hemisphere, but a number of species, which Michaelsen has termed "peregrine", are widely distributed throughout the world, having been transported from the northern hemisphere with plants and soil. The fourteen species that are known from New Zealand are among Michaelsen's peregrine species.

Much work has been done, especially in Europe, on the systematics of Lumbricidae. The family is a very compact one, with only small differences distinguishing genera and species. As a result of the long continued intensive work, smaller and smaller taxonomic units have been recognised. My experience of lumbricids is limited to the New Zealand species and I have taken the definitions set out by Cernosvitov and Evans (1947) and Ude (1929) as standards for the identification of New Zealand species. The definitions of genera and species which follow have come from these two sources.

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KEY TO THE NEW ZEALAND GENERA OF LUMBRICIDAE

a1 Spermathecal pores dorsal to the line of chaeta d, near the dorsal mid line
  b1 Gizzard in xvii only; clitellum extends back not further than xxvii ..... EISENIELLA
  b2 Gizzard takes up more than one segment; clitellum extends back at least as far as xxxii ..... EISENIA
a2 Spermathecal pores in line with chaeta d or ventral to line of chaeta d
  c1 Vesiculae seminales two pairs, in xi, xii ..... BIMASTUS
  c2 Vesiculae seminales three or four pairs, in segments between ix and xii
    d1 Testes and seminal funnels enclosed in testis sacs
      e1 Vesiculae seminales three pairs, in ix, x, xii, those of xii extending through two or more segments ..... LUMBRICUS
      e2 Vesiculae seminales four pairs, in ix, x, xi, xii, those of ix, x small and pyriform, those of xi, xii multilobate ..... OCTOLASIUM
    d2 Testes and seminal funnels not enclosed in testis sacs
      f1 Vesiculae seminales three pairs, in ix, xi, xii ..... DENDROBAENA
      f2 Vesiculae seminales four pairs, in ix, x, xi, xii ..... ALLOLOBOPHORA

Genus ALLOLOBOPHORA Eisen

1874 *Allolobophora* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30:46.
1893 *Allolobophora* (*Allolobophora*), Rosa, Mem. R. Accad. Sci. Torino 43:424.
1900 *Helodrilus* (*Allolobophora*), Michaelsen, Tierreich 10:480.
1929 *Allolobophora*, Ude, Tierwelt Dtsch. 15:119.
1947 *Allolobophora*, Cernosvitov and Evans, Synops. Brit. Fauna, 6:12.

Prostomium usually epilobous, rarely tanylobous. Chaetae more or less closely paired. Male pores on xv. Female pores on xiv, lateral to chaeta b. Spermathecal pores two or three pairs, or pairs of groups (rarely 5–6 pairs or pairs combined with pairs of groups) in 9/10 and 10/11 (rarely 8/9 and 9/10), or 8/9–10/11 (or behind these segments or in 9/10–13/14 or 14/15), in the line of chaetae cd (or ab and cd); occasionally spermathecae are embedded in the body wall or absent. Gizzard taking up two or more segments. Two pairs (rarely one pair) of testes and seminal funnels in x and xi, not in testis sacs. Four pairs of vesiculae seminales in ix, x, xi, xii, those of ix and x usually smaller than those of xi and xii.

Type species: *Allolobophora caliginosa* (Savigny). Type material probably collected from France.

Number of Species in New Zealand: Three. See Table 21.

Distribution in New Zealand: Very widespread in pastures and cultivated soils throughout New Zealand.

KEY TO THE NEW ZEALAND SPECIES OF ALLOLOBOPHORA

a1 First dorsal pore at 4/5 ..... **A. chlorotica**
First dorsal pore at 11/12 or 12/13
  b1 Male papillae large, extending over xiv–xvi; spermathecae in x, xi ..... **A. caliginosa**
  b2 Male papillae limited to xv or extending slightly onto xiv and xvi; spermathecae in ix, x ..... **A. terrestris forma longa**

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TABLE 21. Allolobophora

——	*caliginosa*	*chlorotica*	*terrestris* forma *longa*
Length	40–100 mm.	40–70 mm.	90–120 mm.
Diameter	c. 4 mm.	4–5 mm.	6–9 mm.
Segments	120–150	80–125	160–200
Body form	cylindrical	cylindrical	cylindrical with dorso-ventrally flattened posterior end
Colour	pink anteriorly, greyish posteriorly	variable–green, yellow, pink, grey or slate blue	grey, irridescent
Prostomium	epilobous	epilobous	epilobous
Clitellum	½xxviii–xxxiv	(xxviii) xxix–xxxvii	(xxvii) xxviii–xxxv
First dorsal pore ..	11/12 or 12/13	4/5	12/13
Male pores	xv	xv	xv
Papillae of male pores ..	extending across xiv–xvi	extending across xiv–xvi	limited to xv or extending slightly onto xiv and xvi
Tubercula pubertatis ..	xxxi, xxxiii, each extending onto xxxii	xxxi, xxxiii	(xxxi) xxxii–xxxiv
Septal thickening ..	absent	vi/vii–xiii/xiv	absent
Spermathecae	x, xi	ix, x, xi	ix, x

Allolobophora caliginosa (Savigny)

1826 *Enterion caliginosum* Savigny, Mem. Acad. France 5:180.
1877 *Lumbricus levis* (part), Hutton, Trans. N.Z. Inst. 9:351.
1883 *Dygaster? levis* (part), Hutton, N.Z. J. Sci. 1:585.
1887 *Endrilus levis* (part), Smith, Trans. N.Z. Inst. 19:136.
1891 *Digaster laevis* (part), Beddard, Proc. R. phys. Soc. Edinb. 10:278.
1894 *Allolobophora turgida,* Smith, Trans. N.Z. Inst. 25:117.
1900 *Helodrilus* (*Allolobophora*) *caliginosus,* Michaelsen, Tierreich 10:482.
1901 *Allolobophora caliginosa,* Benham, Trans. N.Z. Inst. 33:134.
1903 *Allolobophora caliginosa,* Benham, Trans. N.Z. Inst. 35:273.
1904 *Helodrilus caliginosus,* Hutton, Index Faunae N.Z. p. 355.
1915 *Helodrilus* (*Allolobophora*) *caliginosa,* Benham, Trans. N.Z. Inst. 47: 184.
1929 *Allolobophora caliginosa,* Ude, Tierwelt Dtsch. 15:119.
1947 *Allolobophora caliginosa,* Cernosvitov and Evans, Synops. Brit. Fauna 6:13–4.
1952 *Allolobophora caliginosa,* Lee, Trans. roy. Soc. N.Z. 79:545.
1953 *Allolobophora caliginosa,* Lee, Trans. roy. Soc. N.Z. 81:49.
1955 *Allolobophora caliginosa,* Waters, N.Z. J. Sci. Tech. A36:516–25.

Two forms of *A. caliginosa,* forma *typica* and forma *trapezoides,* are recognised. The difference between them is very small, and for practical purposes appears to have little significance.

Mr R. L. Nielson, N.Z. Department of Agriculture (pers. comm.) examined about 1,000 specimens of *A. caliginosa,* collected from some twenty New Zealand localities, and found that there was, in every case, a mixture of f. *typica* and f. *trapezoides,* the latter form always more numerous than the former. The highest and lowest proportions of the two forms were:

Locality	f. *typica*	f. *trapezoides*
Raetihi	9·6%	90·4%
Dunedin	48·0%	52·0%

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Cernosvitov and Evans (1947) noted that in Great Britain f. *trapezoides* is rare in the north, where it is replaced by f. *typica*, and that it is most common in southern Europe. Nielson points to a similar meridional trend in the relative abundance of the two forms in New Zealand.

Allolobophora caliginosa forma **typica**

Length 40–100 mm. Diameter c.4 mm. 120–150 segments. Body cylindrical.

Colour pink anteriorly, greyish posteriorly.

Prostomium epilobous.

Clitellum ½xxviii–xxxiv.

Chaetae 8/segment, closely paired: aa:ab:bc:cd:dd=3:1:2:⅔:10. Chaetae ab of ix to xi situated on large glandular papillae, thinner and longer than the normal chaetae, functioning as genital chaetae. Chaetae ab of xxx, xxxii, xxxiii and xxxiv situated on glandular papillae.

First dorsal pore in 11/12 or 12/13.

Male pores on xv, between chaetae b and c, on large papillae which extend anteriorly and posteriorly across xiv and xvi.

Tubercula pubertatis on xxxi and xxxiii, each extending onto xxxii, but separated by a furrow.

No strongly thickened septa.

Spermathecae two pairs, in ix/x, x/xi; small sac, short duct; whole organ embedded in septum, opening to exterior in line with chaetae cd. Vesiculae seminales four pairs, in ix, x, xi, xii.

Allolobophora caliginosa f. **trapezoides** Dugès, 1828

Tubercula pubertatis on (xxx)xxxi–xxxiii(xxxiv), usually broad and slightly elevated on xxxi and xxxiii, so as to form two papillae, connected by a narrow and more transparent bridge, rarely forming a continuous ridge of the same width. Otherwise as for f. *typica*.

Records: A. caliginosa is the most common earthworm in New Zealand. It is found throughout the region, in the soils of pasture lands, cultivated lands, exotic forests and plantations, and occasionally under native vegetation. Very large populations, up to more than three million per acre (see Waters, 1955, p. 521), are encountered in the soils of high producing pastures. *A. caliginosa* is usually found in association with other lumbricid species, but it is frequently dominant, and occasionally very large populations consist almost entirely of this one species.

Allolobophora chlorotica (Savigny)

1826 *Enterion chloroticum* + *Enterion virescens* Savigny, Mem. Acad. France 5:183.
1884 *Allolobophora chlorotica*, Vejdovsky, Syst. Morphol. Olig. p. 60.
1900 *Helodrilus* (*Allolobophora*) *chloroticus*, Michaelsen, Tierreich 10:486.
1929 *Allolobophora chlorotica*, Ude, Tierwelt Dtsch. 15:120.
1947 *Allolobophora chlorotica*, Cernosvitov and Evans, Synops. Brit. Fauna 6:14.

Length 40–70 mm. Diameter 4–5 mm. 80–125 segments. Body cylindrical.

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Colour variable, various shades of green, yellow, pink, grey and slate blue; clitellum pink.

Prostomium epilobous.

Clitellum (xxviii) xxix–xxxvii.

Chaetae 8/segment, closely paired, pairs ventro-lateral and lateral; aa>bc; dd=about ½ circumference. Chaetae cd of x often on white glandular papillae.

First dorsal pore in 4/5.

Male pores on xv on large, elevated, glandular papillae, extending anteriorly and posteriorly over xiv and xvi.

Tubercula pubertatis small, round, elevated papillae on xxxi, xxxiii and xxxv.

Septa vi/vii to xiii/xiv slightly thickened.

Spermathecae three pairs, in ix, x, xi, opening to the exterior at 8/9, 9/10, 10/11, in line with chaetae cd. Vesiculae seminales four pairs, in ix, x, xi, xii; those of ix, x considerably smaller than those of xi, xii.

Localities:

North Island: W. side of Scinde Id., Napier; topsoil, roadside; K.E.L., 4/7/49; 11 specimens. Same data; K.E.L., 28/11/49; 2 specimens. Beside Tukituki Rd., near Hastings; topsoil, pasture; K.E.L., 2/12/49; 11 specimens.

Remarks: This is a rather rare species in New Zealand. It may be more widespread than my records indicate, but it is not as common as *A. caliginosa* or *A. terrestris*. The species has not been recorded from aquatic habitats in New Zealand as it has from Lake Windemere, England.

Allolobophora terrestris (Savigny) forma **longa** (Ude)

1826 *Enterion terrestre* Savigny, Mem. Acad. France 5:180.
1885 *Allolobophora longa* Ude, Z. wiss. Zool, 43:136.
1893 *Allolobophora* (*Allolobophora*) *terrestris*, Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:424.
1900 *Helodrilus* (*Allolobophora*) *terrestris*, Michaelsen, Tierreich 10:483.
1929 *Allolobophora longa*, Ude, Tierwelt Dtsch. 15:119.
1947 *Allolobophora terrestris* forma *longa*, Cernosvitov and Evans, Synops. Brit. Fauna 6:17.
1953 *Allolobophora longa*, Lee, Trans. roy. Soc. N.Z. 81:49.

Length 90–120 mm. Diameter 6–9 mm. 160–200 segments. Body cylindrical with dorso-ventrally flattened posterior end.

Colour grey, irridescent.

Prostomium epilobous.

Clitellum (xxvii)xxviii–xxxv, not prominent, usually with distinct intersegmental grooves.

Chaetae 8/segment, closely paired; pairs ventro-lateral and lateral in position: dd=½ circumference; in mid-body aa=2bc, anterior to clitellum aa<2bc, posterior to clitellum aa>2bc; ab>cd; bc≫ab. Chaetae ab of ix–xii and xxxi, xxxiii and xxxiv on glandular papillae and functioning as genital chaetae.

First dorsal pore in 12/13.

Male pores on xv, with raised glandular borders limited to xv or extending slightly onto xiv and xvi.

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Tubercula pubertatis oval, extending over (xxxi)xxxii-xxxiv, one on each side, between chaetae b and c.

Septal thickening absent.

Spermathecae two pairs, in ix, x, opening to the exterior by short ducts, at 9/10, 10/11, in line with chaeta c. Vesiculae seminales four pairs, in ix, x, xi, xii, those of ix, x considerably smaller than those of xi, xii.

Records: A. terrestris f. *longa* is found throughout the New Zealand region, in pasture and cultivated soils. It is not as common as *A. caliginosa,* except in parts of central Hawke's Bay, in the vicinity and east of Hastings, where it is sometimes found in association with *A. caliginosa* and other lumbricid species in pastures, and frequently dominates the earthworm population, as does *A. caliginosa* in other districts. Where *A. terrestris* is dominant, population densities comparable with those attained by *A. caliginosa* are found.

Genus Bimastus Moore

1895 *Bimastus* Moore, J. Morph. 10:473.
1900 *Helodrilus* (*Bimastus*), Michaelsen, Tierreich 10:501.
1929 *Bimastus,* Ude, Tierwelt Dtsch. 15: 118.
1947 *Bimastus,* Cernosvitov and Evans, Synops. Brit. Fauna 6:17.

Small, darkly pigmented worms. Prostomium epilobous or tanylobous. Chaetae closely or widely paired. Clitellum does not extend beyond xxxiii. Male pores on xv. Female pores on xiv, lateral to chaeta b. Spermathecal pores usually absent or, rarely, incompletely developed organs open in line with chaeta c at 9/10 or 10/11 or 9/10 and 10/11, or two pairs of normally developed organs open at 9/10, 10/11, in line with c or d. Tubercula pubertatis absent or indistinct in species without spermathecae. Gizzard taking up two or more segments. Two pairs of testes and seminal funnels, in x, xi, not enclosed in testis sacs. Vesiculae seminales two pairs, in xi, xii, or absent.

Type species: *Bimastus palustris* Moore. The type specimen was collected from eastern U.S.A.

Number of Species in New Zealand: Two. (See Table 22.)

Distribution in New Zealand: I have not collected any representatives of this genus, and am indebted to Mr R. L. Nielson (pers. comm.) for information on the occurrence of *Bimastus* spp. in New Zealand. He has collected specimens from a few localities in North and South Islands.

Benham (1909, p. 289) recorded a species, which he identified as *Bimastus* (*Helodrilus*) *constrictus,* from Campbell Island. This name is wrong since *Helodrilus* (Hoffmeister, 1845) cannot be a subgenus of *Bimastus* (Moore, 1895), in accordance with the law of priority. *Helodrilus* (*Bimastus*) *constrictus* is synonymous with ***Bimastus tenuis*** and this is probably the species identified by Benham.

Key to the New Zealand Species of Bimastus

a$_1$ Ventral chaetae of xvi on broad glandular papillae; prostomium epilobous ..... **B. tenuis**

a$_2$ Ventral chaetae of xvi not on papillae; prostomium tanylobous ..... **B. eiseni**

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TABLE 22. Bimastus

——	*eiseni*	*tenuis*
Length	30–64 mm.	20–85 mm.
Diameter	2–5 mm.	c. 3 mm.
Segments	75–111	56–120
Body form	cylindrical	cylindrical
Colour	violet or reddish dorsally, yellowish ventrally, clitellum red	brownish red with blue tint dorsally, intersegmental grooves and ventral surface pink
Prostomium	tanylobous	epilobous
Clitellum	xxiv–xxxiii	(xxv, xxvi) xxvii–xxx (xxxi, ½xxxii, xxxiii)
First dorsal pore	5/6	5/6
Male pores	xv	xv
Spermathecal pores ..	absent	usually absent, sometimes at 9/10 and/or 10/11
Tubercula pubertatis ..	absent	sometimes absent, when present on (xxviii, ½xxviii, xxix) ½xxix–xxx (½xxxi, xxxi)

Nielson based his identifications of species on external characters only, and since his collections were destroyed it has not been possible to make dissections. Nielson's notes on external characters, however, leave no doubt of the identity of the two species. The diagnoses given below are based on those of Cernosvitov and Evans (1947), with additional notes from Nielson.

Bimastus eiseni (Levinsen)

1884 *Lumbricus eiseni* Levinsen, Vidensk. Medd. dansk naturh. Foren. Kbh., 1883, p. 241.
1893 *Allolobophora eiseni,* Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:462.
1900 *Helodrilus* (*Bimastus*) *eiseni,* Michaelsen, Tierreich 10:503.
1929 *Bimastus eiseni,* Ude, Tierwelt Dtsch. 15:118.
1947 *Bimastus eiseni,* Cernosvitov and Evans, Synops. Brit. Fauna 6:18.

Length 30–64 mm. Diameter 2–5 mm. 75–111 segments. Body cylindrical.

Colour bright violet or reddish dorsally, yellowish ventrally, clitellum red.

Prostomium tanylobous.

Clitellum prominent, extending over xxiv–xxxiii dorsally and laterally, and xxv–xxxii ventrally (in one of Nielson's specimens xxv–xxxi ventrally).

Chaetae 8/segment, closely paired: aa=2ab=bc; bc=2½cd.

First dorsal pore in 5/6.

Male pores on xv, on small but conspicuous white glandular papillae.

Tubercula pubertatis absent.

Spermathecae absent. Vesiculae seminales two pairs, in xi, xii.

Localities: Nielson has collected the species from two localities in peat soils near Hamilton.

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Bimastus tenuis (Eisen)

1874 *Allolobophora tenuis* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 31(2): 44.
1884 *Allolobophora constricta,* Rosa, Lumbric. Piemonte p. 38.
1885 *Octolasion constrictum,* Örley, Ertek. Term. Magyar Akad. 15 (18) :21.
1889 *Lumbricus* (*Allolobophora*) *tenuis,* Vaillant, Hist. nat. Annel. 3:144.
1900 *Helodrilus* (*Bimastus*) *constrictus,* Michaelsen, Tierreich 10:503.
1909 *Bimastus* (*Helodrilus*) *constrictus,* Benham, Subant. Is. N.Z. 1: 278.
1915 *Helodrilus* (*Bimastus*) *constrictus,* Benham, Trans. N.Z. Inst. 47:185.
1929 *Bimastus tenuis. Ude,* Tierwelt Dtsch. 15:118.
1947 *Bimastus tenuis,* Cernosvitov and Evans, Synops. Brit. Fauna 6:19.

Length 20–85 mm. Diameter c.3 mm. 90–120 segments. (Nielson has found specimens with 56, 57, 64 and 66 segments, but considers that these specimens may have lost some posterior segments when attacked by birds.) Body cylindrical.

Colour brownish red with blue tint dorsally, ventral side and intersegmental furrows pink.

Prostomium epilobous.

Clitellum (xxv, xxvi)xxvii–xxx(xxxi, ½xxxii, xxxiii).

Chaetae 8/segment, widely paired: aa>bc>cd>ab; bc=2ab. Chaetae ab of xvi on broad glandular papillae, functioning as genital chaetae.

First dorsal pore in 5/6.

Male pores on xv, on papillae limited to xv.

Tubercula pubertatis sometimes indistinct or absent; when present on (xxviii, ½xxviii, xxix) ½xxix-xxx (½xxxi, xxxi).

Spermathecae usually absent, occasionally present, in which case opening at 9/10 and/or 10/11. Vesiculae seminales two pairs, in xi, xii.

Localities: Nielson has collected the species from two localities, Waikite Valley, near Rotorua, and Taieri Mouth, near Dunedin. He notes that specimens are most commonly found under cow pats at the former site.

Genus Dendrobaena Eisen

1874 *Dendrobaena* Eisen, Öfvers. VentenskAkad. Förh. Stockh. 30 (8) :46.
1893 *Allolobophora* (*Dendrobaena*), Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:424.
1900 *Helodrilus* (*Dendrobaena*), Michaelsen, Tierreich 10:488.
1929 *Dendrobaena,* Ude, Tierwelt Dtsch. 15:121.
1947 *Dendrobaena,* Cernosvitov and Evans, Synops. Brit. Fauna 6:19.

Darkly pigmented worms, usually red. Prostomium epilobous or tanylobous. Chaetae usually widely paired or distant, rarely closely paired. Clitellum does not extend beyond xxxvii. Male pores on xv. Female pores on xiv, lateral to chaeta b. Spermathecal pores in line with chaetae c or d, two, three or four pairs, at 9/10, 10/11, or 9/10–11/12, or 7/8–10/11. Gizzard taking up two or more segments. Two pairs of testes and seminal funnels, not enclosed in testis sacs. Vesiculae seminales three, rarely four pairs, in ix, xi, xii or ix, x, xi, xii, in which case those of x considerably smaller than those of ix.

Type species: *Dendrobaena octaedra* (Savigny) (= *D. boecki* Eisen).

Number of species in New Zealand: Two.

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Distribution in New Zealand: As with *Bimastus,* I am indebted to Nielson (pers. comm.) for information on this genus, which I have not collected from New Zealand. Nielson states that the genus is probably fairly widespread in compost heaps, which it invades usually during the earlier stages of decomposition (outside the heated zone). He has collected specimens from a number of localities in the North Island.

KEY TO THE NEW ZEALAND SPECIES OF DENDROBAENA

a_1 Body cylindrical; tubercula pubertatis on xxix–xxx ..... **D. rubida**
a_2 Body dorso-ventrally compressed; tubercula pubertatis on (½xxvii)xxviii–xxx ..... **D. subrubicunda**

The species resemble each other very closely (Table 23). Nielson has found that *D. rubida* is more common than *D. subrubicunda,* and he states that the latter species is larger than the former; the average weight of 340 clitellate specimens of *D. rubida* was 90 mg. while that of 12 clitellate specimens of *D. subrubicunda,* collected at the same time, was 167 mg.

TABLE 23. Dendrobaena

——	*rubida*	*subrubicunda*
Length	30–60 mm.	27–90 mm.
Diameter	3–4 mm.	2–4 mm.
Segments	50–100	60–110
Body form	cylindrical	dorso-ventrally compressed
Colour	deep red, often with purplish tinge; few posterior segments yellow to orange; clitellum pale	deep red with few posterior segments yellow to orange; clitellum pale
Prostomium	epilobous	epilobous
Clitellum	(xxv, xxvi) xxvii–xxxi (xxxii)	(xxv) ½xxv–xxxi (xxxii)
First dorsal pore ..	5/6	5/6
Male pores	xv	xv
Spermathecal pores ..	9/10, 10/11	9/10, 10/11
Tubercula pubertatis ..	xxix–xxx	(½xxvii) xxviii–xxx
Vesiculae seminales ..	ix, xi, xii	ix, xi, xii

Dendrobaena rubida (Savigny)

1826 *Enterion rubidum* Savigny, Mem. Acad. France 5:182.
1845 *Lumbricus puter* (part), Hoffmeister, Regenwürmer p. 33.
1874 *Allolobophora arborea,* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8):49.
1889 *Lumbricus* (*Allolobophora*) *puter* (part), Vaillant, Hist. nat. Annel. 3:141.
1893 *Allolobophora putris arborea* (part), Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:433.
1900 *Helodrilus* (*Dendrobaena*) *rubidus,* Michaelsen, Tierreich 10:490.
1904 *Helodrilus rubidus,* Hutton, Index Faunae N.Z. p. 355.
1929 *Dendrobaena rubida,* Ude, Tierwelt Dtsch. 15:121.
1947 *Dendrobaena rubida,* Cernosvitov and Evans, Synops. Brit. Fauna 6:21.

Length 30–60 mm. Diameter 3–4 mm. 50–100 segments. Body cylindrical.

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Colour deep red, often with purplish tinge; a few posterior segments are yellow to orange.

Prostomium epilobous.

Clitellum very conspicuous, on (xxv, xxvi)xxvii–xxxi(xxxii). Cernosvitov and Evans did not record the clitellum commencing on xxv, but Nielson has found it commencing on this segment in some New Zealand specimens.

Chaetae 8/segment, widely paired: cd>ab; bc=2cd; dd=4cd; aa=$1\frac{2}{3}$–2ab. Chaetae ab of xvi always on elevated glandular papillae and functioning as genital chaetae.

First dorsal pore in 5/6.

Male pores on xv, on small oval glandular papillae limited to xv.

Tubercula pubertatis on xxix–xxx.

Spermathecae two pairs, opening to the exterior at 9/10, 10/11, in line with chaeta c; oval spermathecal sac with short duct. Vesiculae seminales three pairs, in ix, xi, xii.

Records: Nielson has collected the species from Horoeka (Dannevirke), Palmerston North, Hauraki Plains (in peat), Hamilton (in peat and compost), Wairakei (in soil).

Dendrobaena subrubicunda (Eisen)

1836 *Lumbricus xanthurus* Templeton, Ann. Mag. nat. Hist. 9:235.
1845 *Lumbricus puter* (part), Hoffmeister, Regenwürmer p. 33.
1874 *Allolobophora subrubicunda* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8):51.
1889 *Lumbricus* (*Allolobophora*) *puter* (part), Vaillant, Hist. nat. Annel. 3:141.
1900 *Helodrilus* (*Dendrobaena*) *rubidus* var. *subrubicunda*, Michaelsen, Tierreich 10:490.
1929 *Dendrobaena subrubicunda*, Ude, Tierwelt Dtsch. 15:121.
1947 *Dendrobaena subrubicunda*, Cernosvitov and Evans, Synops. Brit. Fauna 6:21.

Lenth 27–90 mm. Diameter 2–4 mm. 60–110 segments. Body compressed dorso-ventrally.

Colour deep red, a few posterior segments yellow to orange.

Prostomium epilobous.

Clitellum on (xxv)xxvi–xxxi(xxxii).

Chaetae 8/segment, widely paired: bc=2cd; cd>ab; dd=4cd; aa=$1\frac{2}{3}$ab. Chaetae ab of xvi always on large, broad, glandular papillae and functioning as genital chaetae; some of the ventral chaetae of ix, xvii, xix, xxii–xxxiv occasionally on glandular papillae.

First dorsal pore in 5/6.

Male pores on xv, on small glandular papillae limited to xv.

Tubercula pubertatis oval, on ($\frac{1}{2}$xxvii)xxviii–xxx.

Spermathecae two pairs, opening to the exterior at 9/10, 10/11, in line with chaeta c or between c and d; spermathecal sac ovoidal or bilobed, duct short. Vesiculae seminales three pairs, in ix, xi, xii.

Records: Nielson has collected this species from Hamilton (in compost heap), Wairakei (in turf), Te Awamutu (in a potting soil).

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Genus EISENIA Malm

1877 *Eisenia* (part) Malm, Öfvers. Sallsk. Hort. Göteborg Förh. 1:45.
1893 *Allolobophora* (*Notogama*), Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:424.
1900 *Eisenia,* Michaelsen, Tierreich 10:474.
1910 *Helodrilus* (*Eisenia*), Michaelsen, Annu. Mus. zool. Acad. St. Petersb. 15:10.
1929 *Eisenia,* Ude, Tierwelt Dtsch. 15:116.
1947 *Eisenia,* Cernosvitov and Evans, Synops. Brit. Fauna 6:22.

Prostomium tanylobous or epilobous. Chaetae closely to widely paired or distant. Male pores on xv. Spermathecal pores two or three pairs, at 9/10, 10/11 or 8/9, 9/10, 10/11, near or at the dorsal mid line. Two pairs of testes and seminal funnels in x, xi, not in testis sacs. Two, three or four pairs of vesiculae seminales, in xi, xii or ix, xi, xii or ix, x, xi, xii.

Type species: *Eisenia foetida* (Savigny).

Number of Species in New Zealand: Two. See Table 24.

Distribution in New Zealand: Discontinuously distributed throughout the New Zealand region.

KEY TO THE NEW ZEALAND SPECIES OF EISENIA

a_1 Alternate bands of red-brown (segmental) and bright yellow (intersegmental) on dorsal surface; septal thickening absent ..... **E. foetida**

a_2 Uniform pale red dorsally; septa vi/vii to ix/x thickened ..... **E. rosea** forma **typica**

TABLE 24. Eisenia

——	*foetida*	*rosea* forma *typica*
Length	32–130 mm.	25–85 mm.
Diameter	2–4 mm.	3–4 mm.
Segments	80–110	120–150
Body form	cylindrical	cylindrical
Colour	red-brown transverse bands alternating with intersegmental yellow bands	pale red, unpigmented
Prostomium	epilobous	epilobous
Clitellum	(xxiv or xxv) xxvi–xxxii	(xxiv or xxv) xxvi–xxxii (xxxiii)
First dorsal pore ..	4/5	4/5
Male pores	xv	xv
Papillae of male pores ..	confined to xv	confined to xv
Spermathecal pores ..	9/10, 10/11 dorsal	9/10, 10/11 dorsal
Tubercula pubertatis ..	(xxviii) ½xxviii–xxx (xxxi)	xxix–xxxi or xxix–½xxxi or xxx–xxxi
Septal thickening	absent	vi/vii–ix/x

Eisenia foetida (Savigny)

1826 *Enterion fetidum* Savigny, Mem. Acad. France 5:182.
1837 *Lumbricus foetidus,* Dugès, Ann. Sci. nat., ser. 2, 8:17.
1874 *Allolobophora foetida,* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8):50.
1877 *Lumbricus annulatus,* Hutton, Trans. N.Z. Inst. 9:352.
1887 *Endrilus? annulatus,* Smith, Trans. N.Z. Inst. 19:136.

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1893 *Allolobophora* (*Notogama*) *foetida*, Eisen, Mem. R. Accad. Sci. Torino, ser. 2, 43:424.
1893 *Allolobophora foetidus* (= *Lumbricus annulatus* Hutton), Smith, Trans. N.Z. Inst. 25:117.
1894 *Allolobophora foetidus*, Smith, Trans. N.Z. Inst. 26:159.
1899 *Allolobophora foetida*, Benham, Ann. Mag. nat. Hist., ser. 7, 3:140.
1900 *Eisenia foetida*, Michaelsen, Tierreich 10:475.
1904 *Eisenia foetida*, Hutton, Index Faunae N.Z. p. 355.
1910 *Helodrilus* (*Eisenia*) *foetidus*, Michaelsen, Annu. Mus. zool. Acad. St. Petersb. 15:16.
1915 *Eisenia foetida*, Benham, Trans. N.Z. Inst. 47:184.
1929 *Eisenia foetida*, Ude, Tierwelt Dtsch. 15:116.
1947 *Eisenia foetida*, Cernosvitov and Evans, Synops. Brit. Fauna 6:22.

Length 32–130 mm. Diameter 2–4 mm. 80–110 segments. Body cylindrical.

Colour red, purple or brown, with red-brown transverse pigmented bands on the dorsal aspect, alternating with unpigmented, yellow intersegmental bands.

Prostomium epilobous.

Clitellum (xxiv, xxv)xxvi–xxxii.

Chaetae ornamented, 8/segment, closely paired: aa=bc; dd=$\frac{1}{2}$ circumference.

First dorsal pore in 4/5.

Male pores on xv, on large glandular papillae, confined to xv.

Spermathecal pores at 9/10, 10/11, near dorsal mid line.

Tubercula pubertatis on (xxviii)$\frac{1}{2}$xxviii–xxx(xxxi), oval, raised, glandular areas, ventro-lateral on each side.

Septal thickening absent.

Vesiculae seminales four pairs, in ix, x, xi, xii.

Records: This species is very common in New Zealand in compost heaps, manure heaps and similar concentrations of organic matter. It is rarely found in pasture and garden soils. On Raoul Id. it has been found as the principal earthworm species of forest litters, and is the most common species on the island (see Lee, 1953, p. 50), but on the New Zealand mainland it has not been found in the litters of native forests.

Eisenia rosea (Savigny) forma **typica**

1826 *Enterion roseum* Savigny, Mem. Acad. France, 5:182.
1837 *Lumbricus roseus*, Dugès, Ann. Sci. nat., ser. 2, 8:17.
1874 *Allolobophora mucosa*, Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8):47.
1893 *Allolobophora* (*Notogama*) *rosea*, Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43:424.
1900 *Eisenia rosea*, Michaelsen, Tierreich 10:478.
1910 *Helodrilus* (*Eisenia*) *roseus*, Michaelsen, Annu. Mus. zool. Acad. St Petersb. 15:14.
1929 *Eisenia rosea*, Ude, Tierwelt Dtsch. 15:116.
1947 *Eisenia rosea* forma *typica*, Cernosvitov and Evans, Synops. Brit. Fauna 6:22.

Length 25–85 mm. Diameter 3–4 mm. 120–150 segments. Body cylindrical.

Colour pale red or flesh red, body wall without pigment.

Prostomium epilobous.

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Clitellum (xxiv, xxv)xxvi–xxxii(xxxiii).

Chaetae 8/segment, closely paired: aa>bc; anteriorly dd=½ circumference, posteriorly about ⅓ circumference. Ventral or lateral chaetae of ix and x and/or xii or xiii or xxiv, or only some of them, on elevated prominent glandular papillae, modified into grooved genital chaetae.

First dorsal pore in 4/5.

Male pores on xv, on large glandular papillae usually confined to xv.

Two pairs of spermathecal pores, at 9/10, 10/11, close to dorsal mid line.

Tubercula pubertatis usually on xxix–xxxi or xxix–½xxxi, rarely on xxx–xxxi.

Septa vi/vii to ix/x considerably thickened.

Vesiculae seminales four pairs, in ix, x, xi, xii.

Localities:

North Island: 5 miles S. of Ohura, beside Ohura-Taumarunui road; topsoil, rough pasture; K.E.L., 14/5/50; 1 specimen. Waingaro, near Pukemiro; topsoil, pasture; K.E.L., 20/5/50; 3 specimens. 3 miles N. of Hick's Bay; subsoil, pasture (specimens dormant); K.E.L., 11/1/51; 2 specimens. Near Motu R., Bay of Plenty; topsoil, rough pasture; K.E.L., 12/1/51; 7 specimens. 5 miles E. of Masterton; topsoil, pasture; K.E.L., 17/4/50; 1 specimen. 8 miles E. of Masterton; topsoil, pasture; K.E.L., 17/4/50; 1 specimen. Near Langdale, E. of Masterton; topsoil, rough pasture; K.E.L., 18/4/50; 7 specimens. Woodlands, near Carterton; topsoil, pasture (some dormant in subsoil); K.E.L., 20/4/50; 11 specimens.

South Island: Moutere Hills, near Motueka; topsoil, pine plantation; K.E.L., 27/5/54; 12 specimens. Wharanui; topsoil, manuka; K.E.L., 29/5/54; 4 specimens. Peel Forest, Canterbury; leaf mould, forest; R. R. Forster, 19/1/51; 1 specimen.

Genus EISENIELLA Michaelsen

1900 *Eiseniella* Michaelsen, Tierreich 10:471.
1910 *Helodrilus* (*Eiseniella*), Michaelsen, Annu. Mus. zool. Acad. St Petersb. 15:14.
1929 *Eiseniella,* Ude. Tierwelt Dtsch. 15:115.
1947 *Eiseniella,* Cernosvitov and Evans, Synops. Brit. Fauna 6:115.

Prostomium prolobous or epilobous. Middle and posterior portions of the body almost square in cross section. Chaetae closely paired. Clitellum does not extend beyond xxx. Male pores on xiii, or xiv, or xiv and xv, or xv. Spermathecal pores at 9/10, 10/11, between chaeta d and dorsal mid line. Gizzard in xvii or xvii–xviii. Two pairs of testes and testis funnels, not enclosed in testis sacs. Three or four pairs of vesiculae seminales, in ix, xi, xii or ix, x, xi, xii.

Number of Species in New Zealand: One.

Distribution in New Zealand: The single species is rare in the New Zealand region, but is found in widely scattered localities.

Eiseniella tetraedra (Savigny) forma **typica**

1826 *Enterion tetraedrum* Savigny, Mem. Acad. France, 5:184.
1837 *Lumbricus tetraedrus,* Dugès, Ann. Sci. nat., ser. 2, 8:17.
1874 *Allurus tetraedrus,* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8): 54.
1889 *Lumbricus* (*Allurus*) *tetraedrus,* Vaillant, Hist. nat. Annel. 3:151.
1893 *Allurus tetraedrus,* Smith, Trans. N.Z. Inst. 25:117.
1900 *Eiseniella tetraedra* (*typica*), Michaelsen, Tierreich 10:473.

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1904 *Eiseniella tetraedra,* Hutton, Index Faunae N.Z. p. 355.
1910 *Helodrilus* (*Eiseniella*) *tetraedrus* forma *typica,* Michaelsen, Annu. Mus. zool. Acad. St. Petersb. 15:11.
1929 *Eiseniella tetraedra,* Ude, Tierwelt Dtsch. 15:115.
1932 *Eiseniella* sp., Percival, N.Z. Marine Dep. Bull. 5:41–8.
1947 *Eiseniella tetraedra* forma *typica,* Cernosvitov and Evans, Synops. Brit. Fauna 6:27.

Length 30–60 mm. Diameter 2–4 mm. 60–90 segments. Body cylindrical, anterior to clitellum, quadrangular posterior to clitellum.

Colour variable, dark brown, greenish, brick red or bright golden yellow.

Clitellum (xxii)xxiii–xxvi(xxvii).

Chaetae 8/segment, closely paired: aa:ab:bc:cd:dd = 3:1:3:1:6. Chaetae ab of x, or ix and x, modified as genital chaetae.

First dorsal pore in 4/5.

Male pores on xiii on somewhat raised glandular papillae, which do not extend onto the neighbouring segments and do not differ in colour from them.

Spermathecal pores two pairs, at 9/10, 10/11, between chaeta d and dorsal mid line.

Tubercula pubertatis on (xxiii)½xxiii–xxv(xxvi).

Spermathecae two pairs, in x, xi. Vesiculae seminales four pairs, in ix, x, xi, xii.

Localities:

North Island: Anawhata Stm., near Auckland; under rock in flowing water; J. S. Edwards, 24/5/52; 1 specimen.

South Island: Teal Stm., near Whangamoa Saddle, Nelson; under boulders at stream edge; K.E.L., 26/5/54; 2 specimens. Awatere Valley, c.13 miles from Blenheim-Seddon road junction; swamp on small reversed slope on terrace face; K.E.L., 30/5/54; 2 specimens. Moana; R. R. Forster, 10/3/50; 2 specimens. Beside Waimakiriri R., 3 miles upstream from Bealy; under stones in swift stream; K.E.L., 16/10/53; 3 specimens. Wilkin Valley, near L. Wanaka; ground surface; P. J. Harrigan, 12/52; 1 specimen. Fraser's Dam Road, Alexandra; very wet swampy soil; K.E.L., 12/10/53; 3 specimens.

Subantarctic Islands: Macquarie Id.; M. L. Laird, 1947; 1 specimen.

The habitats from which the species has been collected are all aquatic except that in the Wilkin Valley. This specimen was collected on the ground surface inside a tent, and it is possible that it had been carried there on a boot from a swamp or stream. The species is found mainly in aquatic habitats in Europe.

Genus Lumbricus Linnaeus

1758 *Lumbricus* (part) Linnaeus, Syst. Nat. 10th ed. p. 647.
1774 *Lumbricus* (part), Müller, Verm. Terr. Fluv. 1:24.
1874 *Lumbricus,* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 30 (8):45.
1900 *Lumbricus,* Michaelsen, Tierreich 10:508.
1929 *Lumbricus,* Ude, Tierwelt Dtsch. 15:124.
1947 *Lumbricus,* Cernosvitov and Evans, Synops. Brit. Fauna 6:29.

Prostomium tanylobous. Body darkly pigmented. Chaetae closely paired. Male pores on xv. Female pores on xiv, lateral to line of chaeta b. Spermathecal pores two pairs, at 9/10, 10/11, in line with chaetae cd. Tubercula pubertatis fused to form longitudinal ridges. Gizzard taking up two or more segments. Two pairs of testes and seminal

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funnels, in x, xi, enclosed in testis sacs which are fused to form unpaired median chambers in each of x and xi. Vesiculae seminales three pairs, in ix, x, xii, the last pair extending back through two or more segments.

Type species: *Lumbricus terrestris* Linnaeus.

Number of Species in New Zealand: Three. (See Table 25.)

Distribution in New Zealand: One species very widely distributed throughout the region, two species discontinuously distributed.

KEY TO THE NEW ZEALAND SPECIES OF LUMBRICUS

a_1 First dorsal pore at 6/7; male pores with very small papillae; septal thickening absent ..... **L. castaneus**

a_2 First dorsal pore at 7/8; male pores lack papillae; septa vi/vii to xiv/xv slightly thickened ..... **L. rubellus**

a_3 First dorsal pore at 7/8; male pores on very prominent, broad papillae, extending across xiv–xvi; septa vi/vii to ix/x greatly thickened ..... **L. terrestris**

TABLE 25. Lumbricus

——	*castaneus*	*rubellus*	*terrestris*
Length	30–70 mm.	25–150 mm.	90–300 mm.
Diameter	3·5–4·5 mm.	2–6 mm.	6–9 mm.
Segments	82–100	95–120	110–160
Body form	cylindrical, dorso-ventrally flattened posteriorly	cylindrical, dorso-ventrally flattened posteriorly	cylindrical, strongly compressed and dorso-ventrally flattened posteriorly
Colour	chestnut to violet brown with orange clitellum, irridescent	red-brown or red-violet, irridescent	brownish-red or violet with orange-red clitellum, irridescent
Prostomium	tanylobous	tanylobous	tanylobous
Clitellum	(xxviii) xxix–xxxiii	(xxvi) xxvii–xxxi (xxxii)	(xxxi) xxxii–xxxvii
First dorsal pore	6/7	7/8	7/8
Male pores	xv	xv	xv
Papillae of male pores	very small	absent	extending across xiv–xvi
Spermathecal pores	9/10, 10/11	9/10, 10/11	9/10, 10/11
Tubercula pubertatis	(xxix) xxx–xxxii	xxviii–xxxi or xxviii–xxx or xxviii–½xxxi or xxviii–xxxii	xxxiii–xxxvi or ½xxxiii–½xxxvi
Septal thickening	absent	vi/vii–xiv/xv	vi/vii–ix/x
Posterior vesiculae seminales	xii–xiii	xii–xiii	xii–xiii

Lumbricus castaneus (Savigny)

1826 *Enterion castaneum* + *Enterion pumilum* Savigny, Mem. Acad. France, 5:180.

1837 *Lumbricus castaneus,* Dugès, Ann. Sci. nat., ser. 2, 8:17.

1871 *Lumbricus purpureus,* Eisen, Öfvers. VetenskAkad. Förh. Stockh. 27: 956.

1893 *Lumbricus castaneus,* Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43: 419.

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1893 *Lumbricus purpureus*, Smith, Trans. N.Z. Inst. 25:117.
1900 *Lumbricus castaneus*, Michaelsen, Tierreich 10:510.
1904 *Lumbricus castaneus*, Hutton, Index Faunae N.Z., p. 355.
1929 *Lumbricus castaneus*, Ude, Tierwelt Dtsch. 15:125.
1947 *Lumbricus castaneus*, Cernosvitov and Evans, Synops. Brit. Fauna 6:29.

Length 30–70 mm. Diameter 3·5–4·5 mm. 82–100 segments. Body cylindrical, flattened dorso-ventrally at posterior end.

Colour chestnut to violet brown, irridescent, brownish yellow ventrally, clitellum orange.

Clitellum (xxviii)xxix–xxxiii.

Chaetae 8/segment, closely paired: ab>cd; aa=bc; dd=½ circumference. Chaetae ab of ix or x on pale glandular papillae which are fused ventrally.

First dorsal pore in 6/7.

Male pores on xv, inconspicuous or surrounded by small glandular papillae.

Tubercula pubertatis on (xxix)xxx–xxxii.

No specially thickened septa.

Spermathecal sac oval, pear-, or kidney-shaped, or divided into two parts by a deep constriction. Last pair of vesiculae seminales almost fills xii and xiii.

Records: I have not collected this species, but am indebted to Mr R. L. Nielson (pers. comm.) for information on its occurrence. Nielson has collected it from Cass in the South Island (in soil) and from Rukuhia in the North Island (in peat compost). At Rukuhia, Nielson found specimens up to 70 mm. in length. Cernosvitov and Evans give 35 mm. as the maximum length.

Lumbricus rubellus Hoffmeister

1843 *Lumbricus rubellus* Hoffmeister, 1843, Arch. Naturgesch. 9:187.
1877 *Lumbricus campestris* (part), Hutton, Trans. N.Z. Inst. 9:351.
1883 *Digaster campestris* (part), Hutton, N.Z. J. Sci. 1:586.
1887 *Endrilus campestris* (part), Smith, Trans. N.Z. Inst. 19:137.
1892 *Lumbricus rubellus* var. *curticaudatus*, Friend, J. Linn. Soc. Lond. 24:312.
1893 *Allolobophora rubicunda*, Smith, Trans. N.Z. Inst. 25:117.
1894 *Lumbricus rubellus*, Smith, Trans. N.Z. Inst. 26:156.
1900 *Lumbricus rubellus*, Michaelsen, Tierreich 10:509.
1904 *Lumbricus rubellus*, Hutton, Index Faunae N.Z. p. 355.
1929 *Lumbricus rubellus*, Ude, Tierwelt Dtsch. 10:124.
1947 *Lumbricus rubellus*, Cernosvitov and Evans, Synops. Brit. Fauna 6:31.
1952 *Lumbricus rubellus*, Lee, Trans. roy. Soc. N.Z. 79:545.
1955 *Lumbricus rubellus*, Waters, N.Z. J. Sci. Tech. A36:516–25.

Length 25–150 mm. Diameter 2–6 mm. 95–120 segments. Body cylindrical, posterior end flattened dorso-ventrally.

Colour red-brown or red-violet and irridescent dorsally. Cream ventrally.

Prostomium tanylobous.

Clitellum (xxvi)xxvii–xxxi(xxxii).

Chaetae 8/segment, closely paired: ab>cd; aa>bc=5ab; dd=½ circumference of body. Chaetae ab of x often on glandular papillae.

First dorsal pore in 7/8.

Male pores on xv, inconspicuous, without glandular papillae.

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Tubercula pubertatis usually on xxviii–xxxi, occasionally on xxviii–xxx, xxviii–½xxxi or xxviii–xxxii, usually a little elevated and broader on xxviii and xxxi than on other segments.

Septa vi/vii to xiv/xv slightly thickened.

Spermathecae spherical, with short ducts. Last pair of vesiculae seminales occupies xii–xiii.

Records: This species is very widely distributed in the soils of pastures and cultivated lands throughout the New Zealand mainland and on outlying islands. It is frequently found in association with *Allolobophora caliginosa, A. terrestris,* and *Octolasium cyaneum,* and is sometimes the dominant species in an earthworm population. Numbers of *L. rubellus* in such a population may be very large, but not as large as those of *A. caliginosa* in populations where that species is dominant. *L. rubellus* is more commonly found in garden soils than is *A. caliginosa.*

L. rubellus is the most common species of the genus in the British fauna and is widely distributed in habitats similar to those in which it is found in New Zealand.

Lumbricus terrestris Linnaeus

1758 *Lumbricus terrestris* (part) Linnaeus, Syst. Nat. 10th ed. p. 647.
1774 *Lumbricus terrestris* (part), Müller, Verm. Terr. Fluv. 1:24.
1826 *Enterion herculeum* Savigny, Mem. Acad. France 5:180.
1837 *Lumbricus herculeus,* Dugès, Ann. Sci. nat., ser. 2, 8:17.
1842 *Lumbricus agricola* Hoffmeister, Verm. Lumbric. p. 24.
1893 *Lumbricus terrestris,* Smith, Trans. N.Z. Inst. 25:117.
1900 *Lumbricus terrestris,* Michaelsen, Tierreich 10:511.
1904 *Lumbricus terrestris,* Hutton, Index Faunae N.Z. p. 355.
1929 *Lumbricus terrestris,* Ude, Tierwelt Dtsch. 15:125.
1947 *Lumbricus terrestris,* Cernosvitov and Evans, Synops. Brit. Fauna 6:31.

Length 90–300 mm. Diameter 6–9 mm. 110–160 segments. Body cylindrical, posterior end strongly compressed dorso-ventrally and flattened in an oar shape.

Colour: deeply pigmented brownish red or violet dorsally, cream ventrally, with prominent orange-red clitellum.

Prostomium tanylobous.

Clitellum (xxxi)xxxii–xxxvii, only slightly developed ventrally.

Chaetae 8/segment, enlarged at both ends of the body and widely paired, of moderate size and closely paired in the middle.

Ventral chaetae of xxvi or xxv and xxvi on broad glandular papillae, modified into genital chaetae.

First dorsal pore in 7/8.

Male pores on xv, on large, raised, glandular papillae, extending anteriorly and posteriorly over xiv and xvi.

Tubercula pubertatis on xxxiii–xxxvi, or occasionally ½xxxiii–½xxxvi.

Septa vi/vii to ix/x greatly thickened.

Spermathecae two pairs, in ix, x; spherical with short ducts. Last pair of vesiculae seminales occupies xii–xiii.

Records: This species is quite common in garden soils in Auckland, Hamilton, and probably in other nearby towns. It has not been collected from pastures. Since it lives in burrows up to 8 ft. deep, it is quite likely that it is more common than the records indicate, but is rarely

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found. Smith (1894, p. 157) noted that "fully-matured individuals of *Lumbricus terrestris* are plentiful [in the South Island], ranging from 1 in. to 6 in. in length; the former occur in poor soil, the latter in decayed or decaying vegetable matter". From the range of sizes given and the fact that the species was plentiful, it may reasonably be inferred that the species seen by Smith was not *L. terrestris*.

L. terrestris is the classical "type earthworm" of zoology text books, and detailed information on the species is readily available.

Genus OCTOLASIUM Örley

1885 *Octolasion* (corr. *Octolasium*) Örley, Ertek. Term. Magyar Akad. 15 (18) :13.
1893 *Allolobophora* (*Octolasion*), Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43 :424.
1900 *Octolasium*, Michaelsen, Tierreich 10 :504.
1929 *Octolasium*, Ude, Tierwelt Dtsch. 15 :123.
1947 *Octolasium*, Cernosvitov and Evans, Synops. Brit. Fauna 6 :32.

Prostomium usually epilobous, rarely tanylobous. Chaetae usually widely spaced, sometimes closely paired. Male pores on xv. Female pores on xiv, lateral to line of chaeta b. Spermathecal pores two to eight pairs opening at 9/10, 10/11 or 5/6 to 12/13, in line with chaetae c or slightly lateral or medial to line of chaeta c. Tubercula pubertatis fused to form longitudinal ridges. Gizzard taking up two or more segments. Two pairs (rarely one pair) of testes and funnels, usually enclosed in two pairs (rarely one pair) of testis sacs; if testis sacs absent, the septa of the testis segments connected by horizontal bands or fused by their margins to form narrow chambers. Usually four pairs of vesiculae seminales, in ix, x, xi, xii, rarely two pairs, in xi, xii, or x, xii.

Type species: *Octolasium cyaneum* (Savigny)

Number of Species in New Zealand: One.

Distribution in New Zealand: Throughout the mainland and outlying islands in pasture and garden soils; occasionally under native vegetation.

Octolasium cyaneum (Savigny)

1826 *Enterion cyaneum* (part) Savigny, Mem. Acad. France, 5 :181.
1837 *Lumbricus cyaneus*, Dugès, Ann. Sci. nat., ser. 2, 8 :17.
1845 *Lumbricus stagnalis* (part) Hoffmeister, Regenwürmer p. 35.
1867 *Lumbricus alyattes* Kinberg, Öfvers. VetenskAkad. Förh. Stockh. 23 : 99.
1893 *Allolobophora* (*Octolasion*) *cyanea* (part), *Allolobophora cyanea stagnalis*, Rosa, Mem. R. Accad. Sci. Torino, ser. 2, 43 :424, 455, 456.
1900 *Octolasium cyaneum*, Michaelsen, Tierreich 10 :506.
1904 *Octolasium cyaneum*, Hutton Index Faunae N.Z. p. 355.
1929 *Octolasium cyaneum*, Ude, Tierwelt Dtsch. 15 :123.
1947 *Octolasium cyaneum*, Cernosvitov and Evans, Synops. Brit. Fauna 6 :33.
1952 *Octolasium cyaneum*, Lee, Trans. roy. Soc. N.Z. 79 :545.

Length 65–180 mm. Diameter 7–8 mm. 100–150 segments. Body cylindrical, octagonal at the posterior end.

Colour bluish grey, often with lilac blue dorsal line and last four or five segments bright yellow, clitellum red or orange-red.

Prostomium epilobous.

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Clitellum prominent, on xxix–xxxiv.

Chaetae 8/segment, widely paired posteriorly, more closely paired anteriorly. Chaetae ab of xix occasionally on white glandular papillae.

First dorsal pore in 11/12.

Male pores on xv, on narrow papillae limited to xv.

Tubercula pubertatis on xxx–xxxiii, occasionally extending slightly onto xxix and xxxiv.

Spermathecae two pairs, in ix, x; round sac with short narrow duct opening to exterior between lines of chaetae c and d. Vesiculae seminales four pairs, in ix, x, xi, xii, those of ix, x pyriform, those of xi, xii multilobed and larger than those of ix, x.

Records: This species is widespread in New Zealand, but is not as common as *Allolobophora caliginosa* or *Lumbricus rubellus*. In England it is found mostly under stones, under moss and in argillo-calcareous and moist soils (Cernosvitov and Evans, 1947). In New Zealand it is principally a soil dweller and is found in soils supporting low fertility pastures, living at depths of 4–6 inches or more. It is frequently found in small, isolated remnant areas of native forest which are surrounded by pasture lands and are frequented by stock. The species occurs in soils supporting pastures of high fertility, but it is then a minor component of an earthworm population dominated by one or more of the species *Allolobophora caliginosa, A. terrestris,* and *Lumbricus rubellus*.

SPECIES TO BE DELETED FROM THE NEW ZEALAND LIST

Family **EUDRILIDAE** Beddard, 1895

Genus EUDRILUS Perrier, 1871

Eudrilus eugeniae (Kinberg)

1867 *Lumbricus eugeniae* Kinberg, Öfvers. VetenskAkad. Förh. Stockh. 23:98.
1895 *Eudrilus eugeniae,* Beddard, Monograph p. 604.
1900 *Eudrilus eugeniae,* Michaelsen, Tierreich 10:402.

E. eugeniae is a peregrine species, which is said to have originated in Africa. It is mentioned by Beddard (1895a) and by Michaelsen (1900) as occurring in New Zealand. According to Benham (1950b) the notion that *E. eugeniae* occurs in New Zealand arose from an error made by Smith (1887). Hutton (1877) recorded a species which he named *Lumbricus levis*. (The type material of Hutton's species was re-examined by Benham (1899) who found that it consisted of two distinct species, one of which belonged to the genus *Octochaetus* while the other was the lumbricid *Allolobophora caliginosa*.) Smith (1887), for no apparent reason, removed Hutton's *Lumbricus levis* to *Eudrilus* (which he mis-spelt *Endrilus*). Beddard, again for no apparent reason, took Smith's *Endrilus levis* for *Eudrilus eugeniae,* and so the error has been carried forward in the literature. So far as I am aware, there are no specimens of *E. eugeniae* in existence that have been collected in New Zealand. The species has not been collected in the present investigation and it is unlikely that it does occur in New Zealand.

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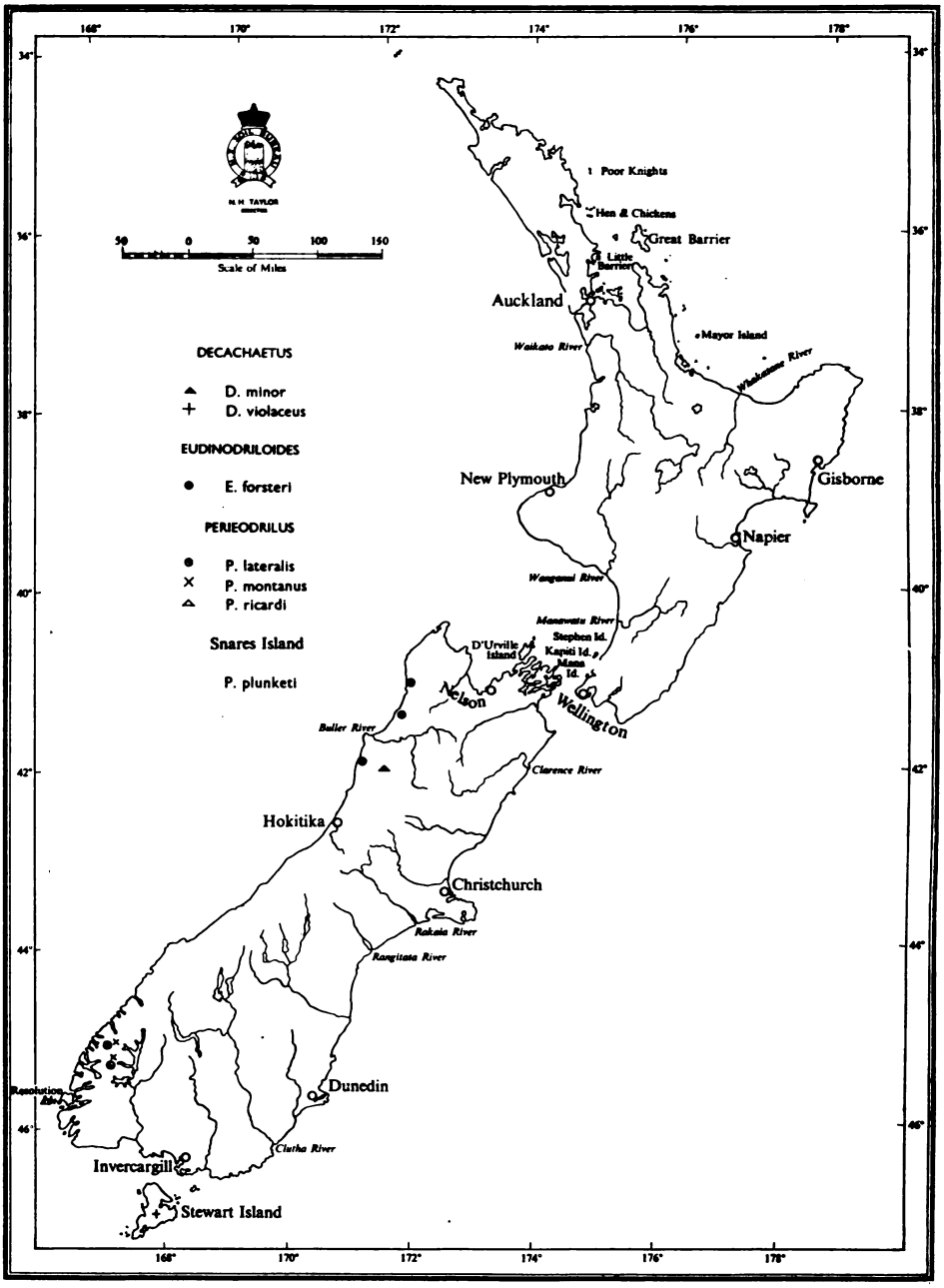

FIG. 356. Distribution of the genera *Decachaetus, Eudinodriloides,* and *Perieodrilus*

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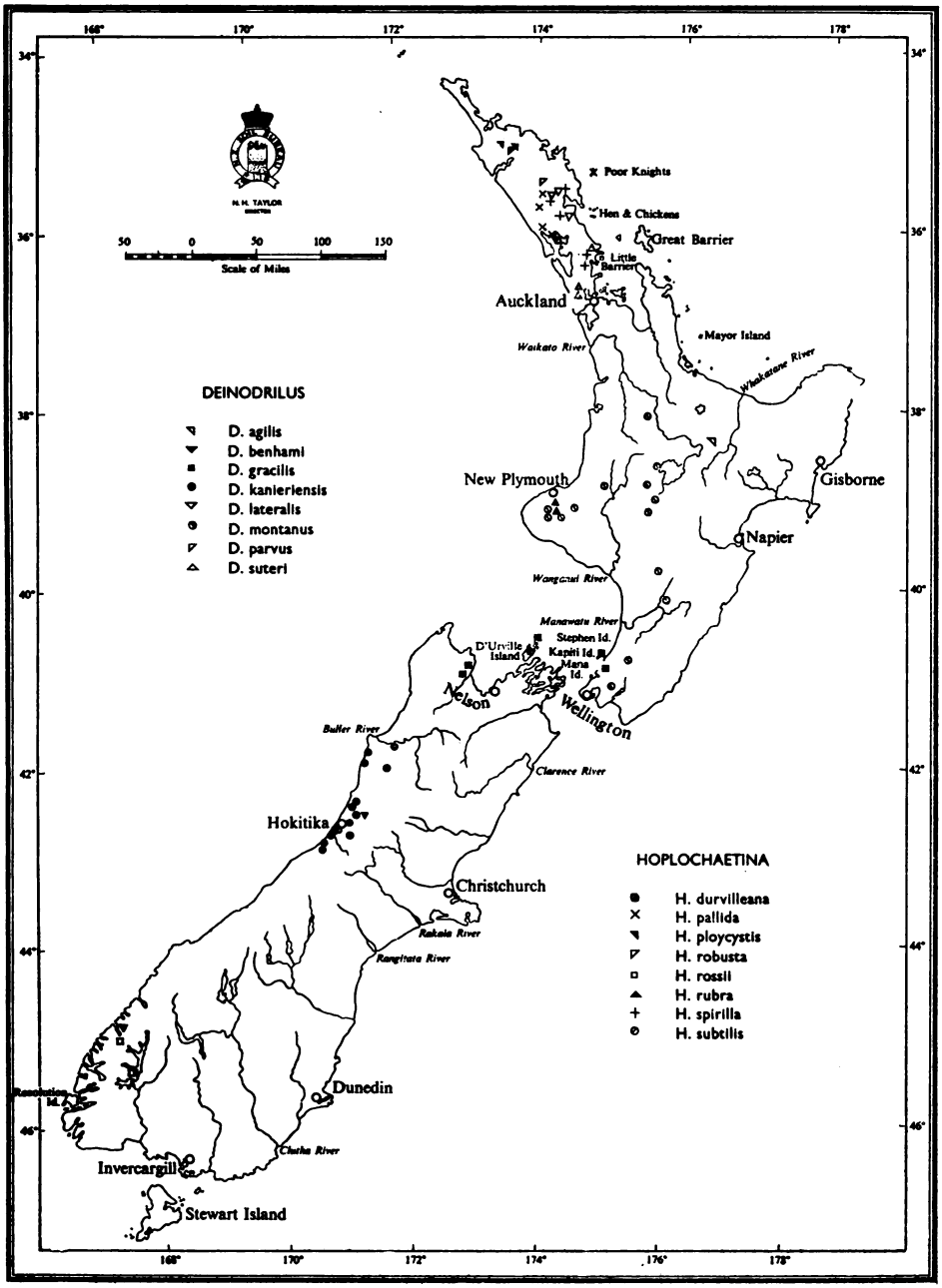

FIG. 357. Distribution of the genera *Deinodrilus* and *Hoplochaetina*. (For *H. ploycystis* read *H. polycystis*.)

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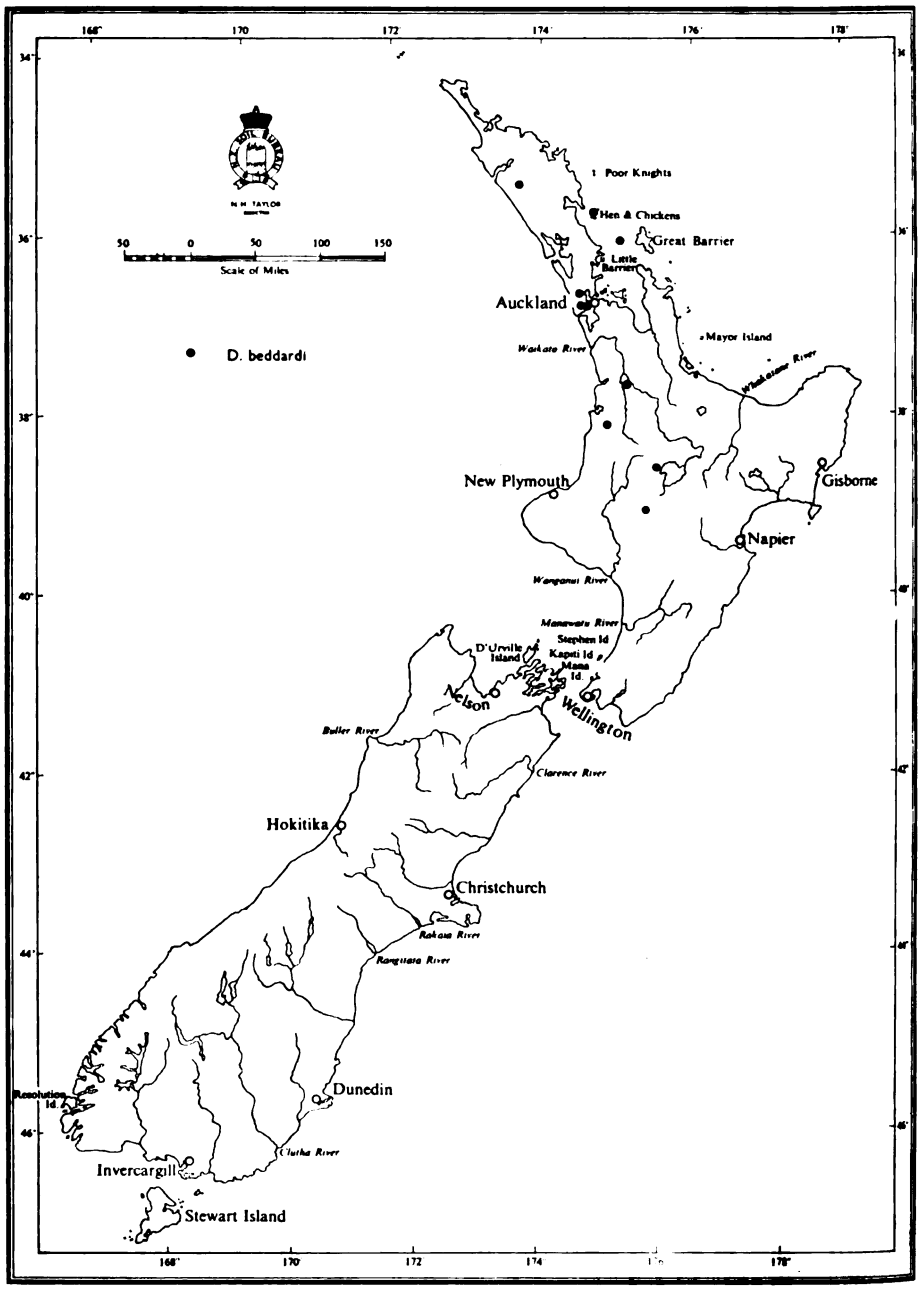

FIG. 358. Distribution of the genus *Dinodriloides*

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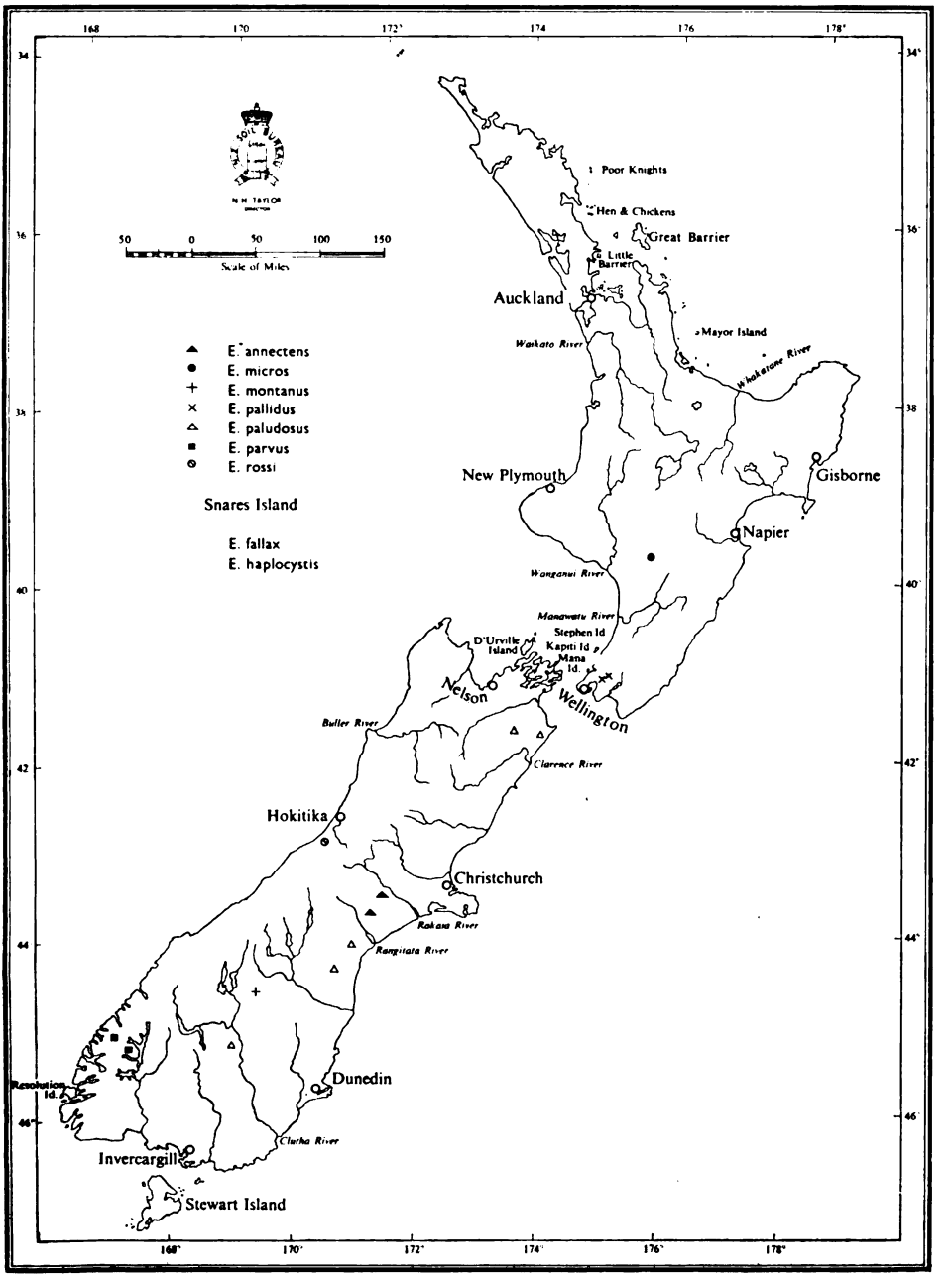

FIG. 359. Distribution of the New Zealand species of the genus *Eodrilus*

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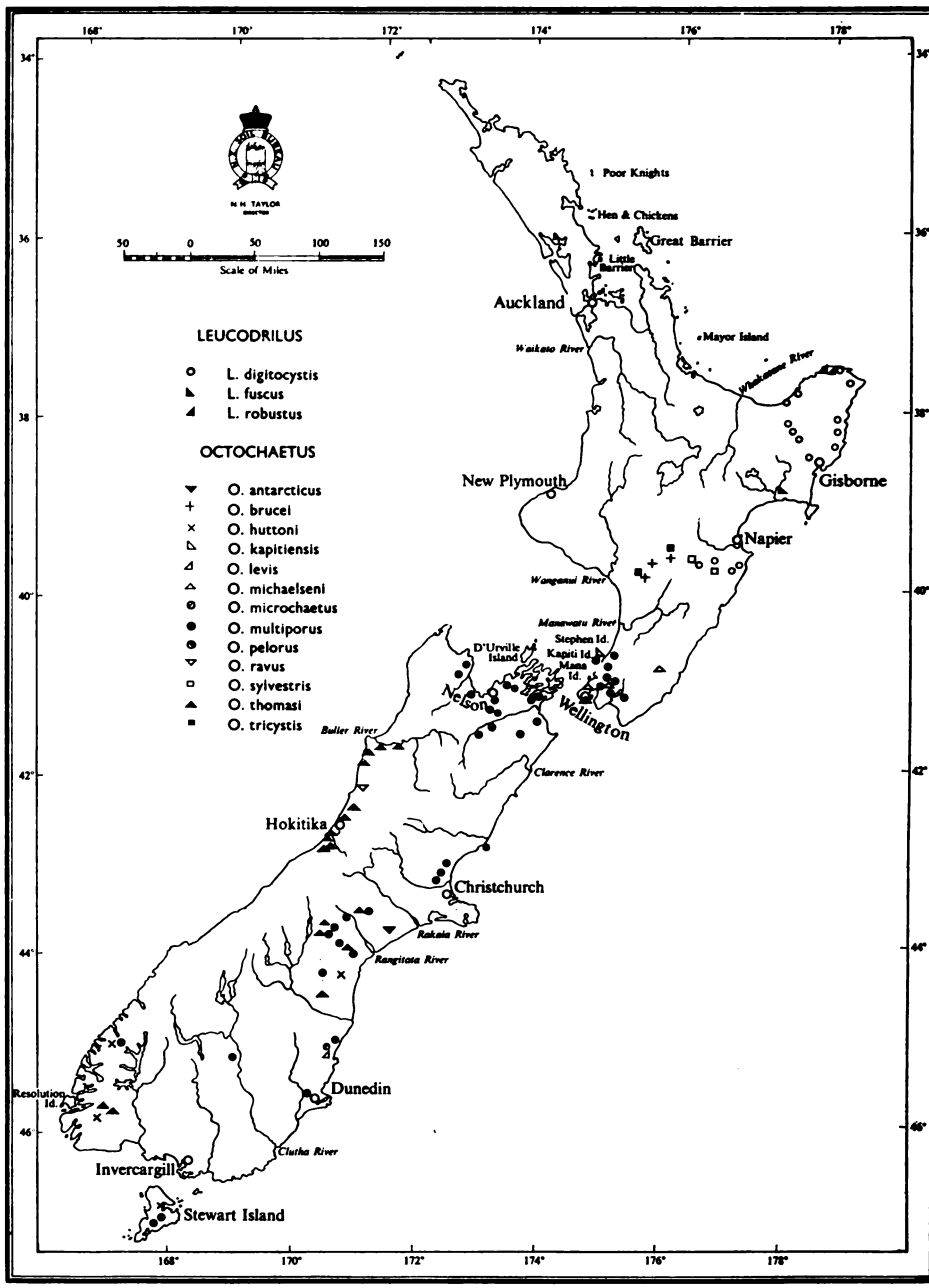

FIG. 360. Distribution of the genera *Leucodrilus* and *Octochaetus*

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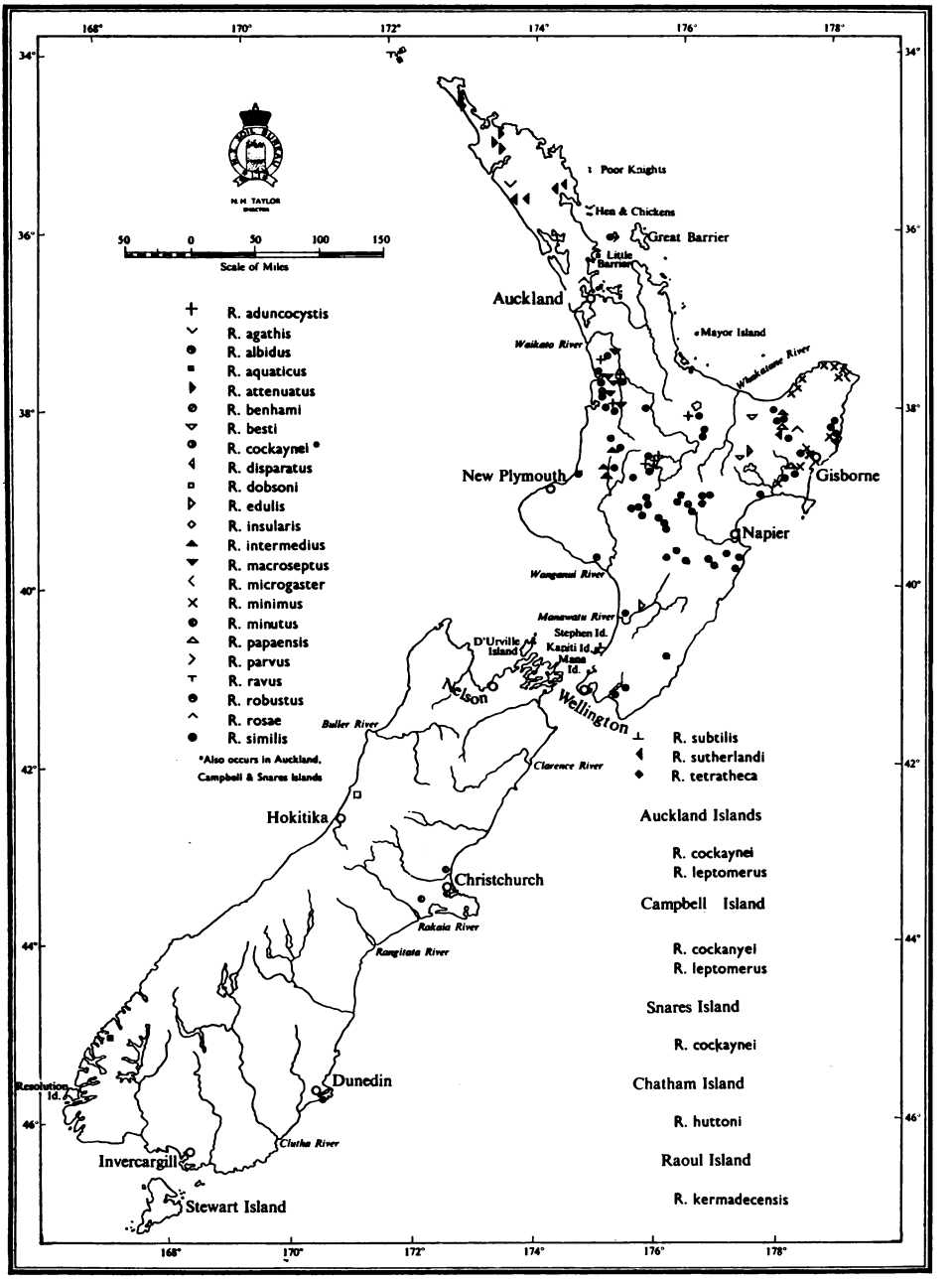

FIG. 361. Distribution of the genus *Rhododrilus*. (Under Campbell Island, for *R. cockanyei* read *R. cockaynei*.)

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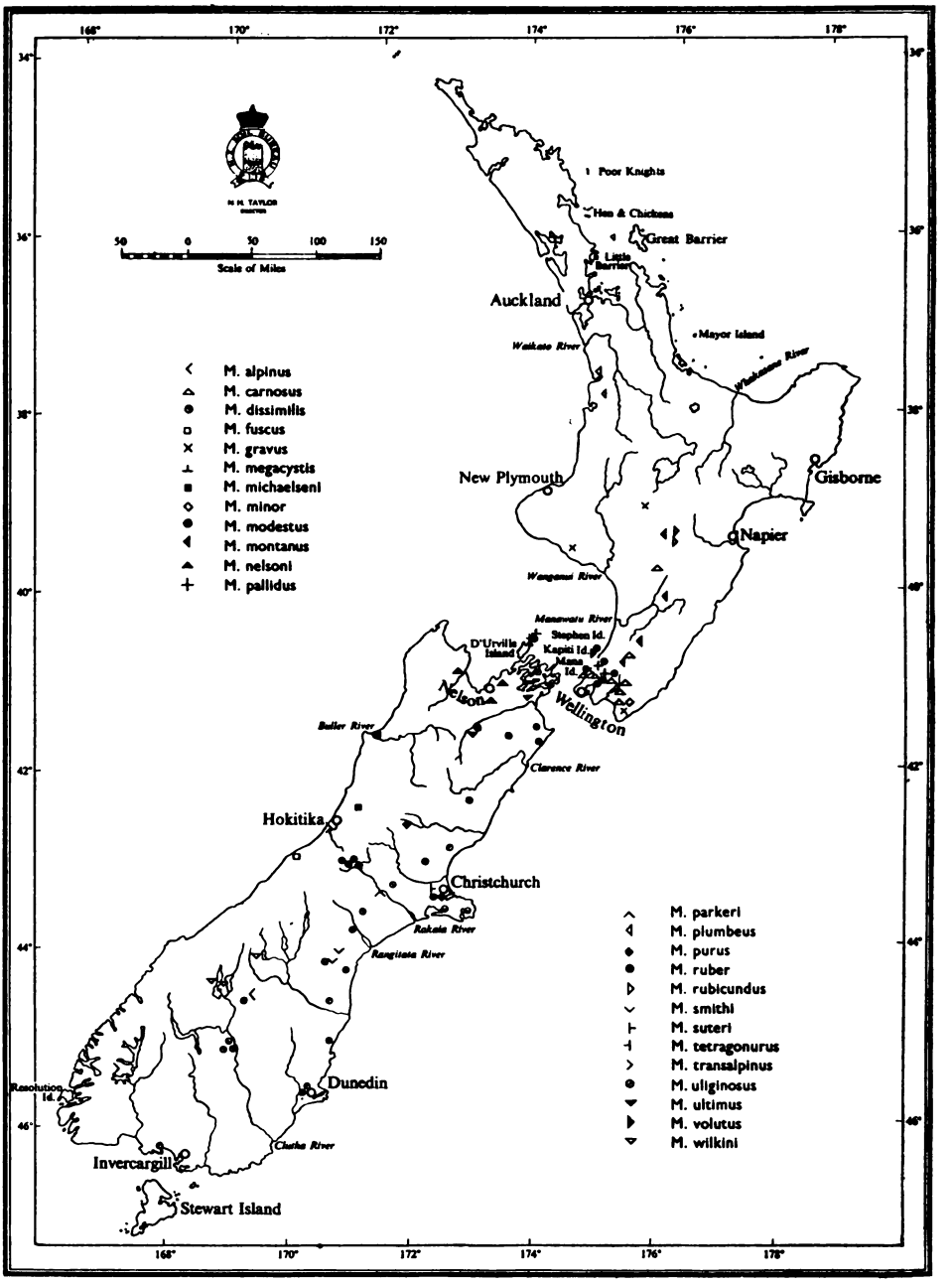

FIG. 362. Distribution of the genus *Maoridrilus*

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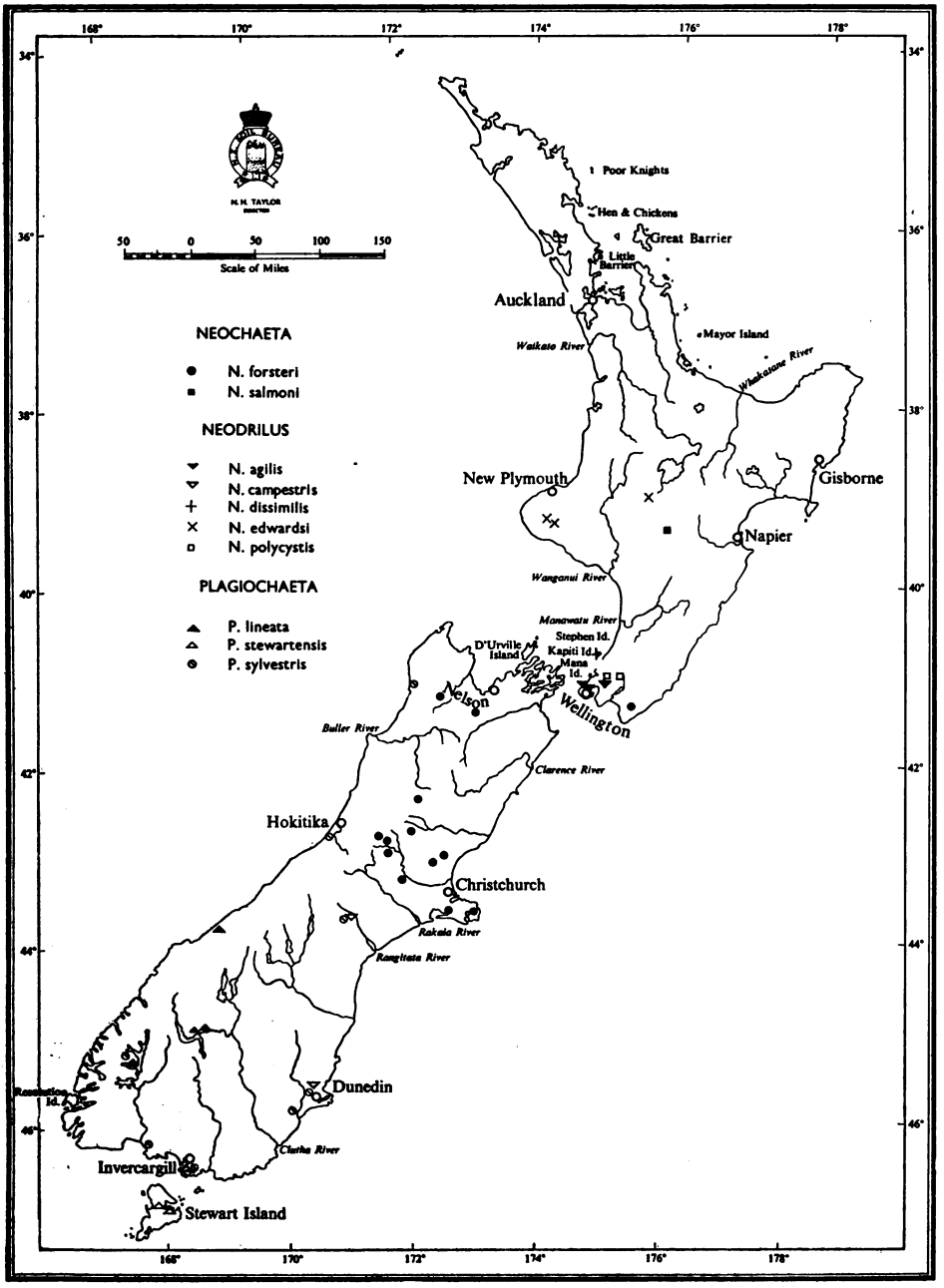

FIG. 363. Distribution of the genera *Neochaeta*, *Neodrilus*, and *Plagiochaeta*

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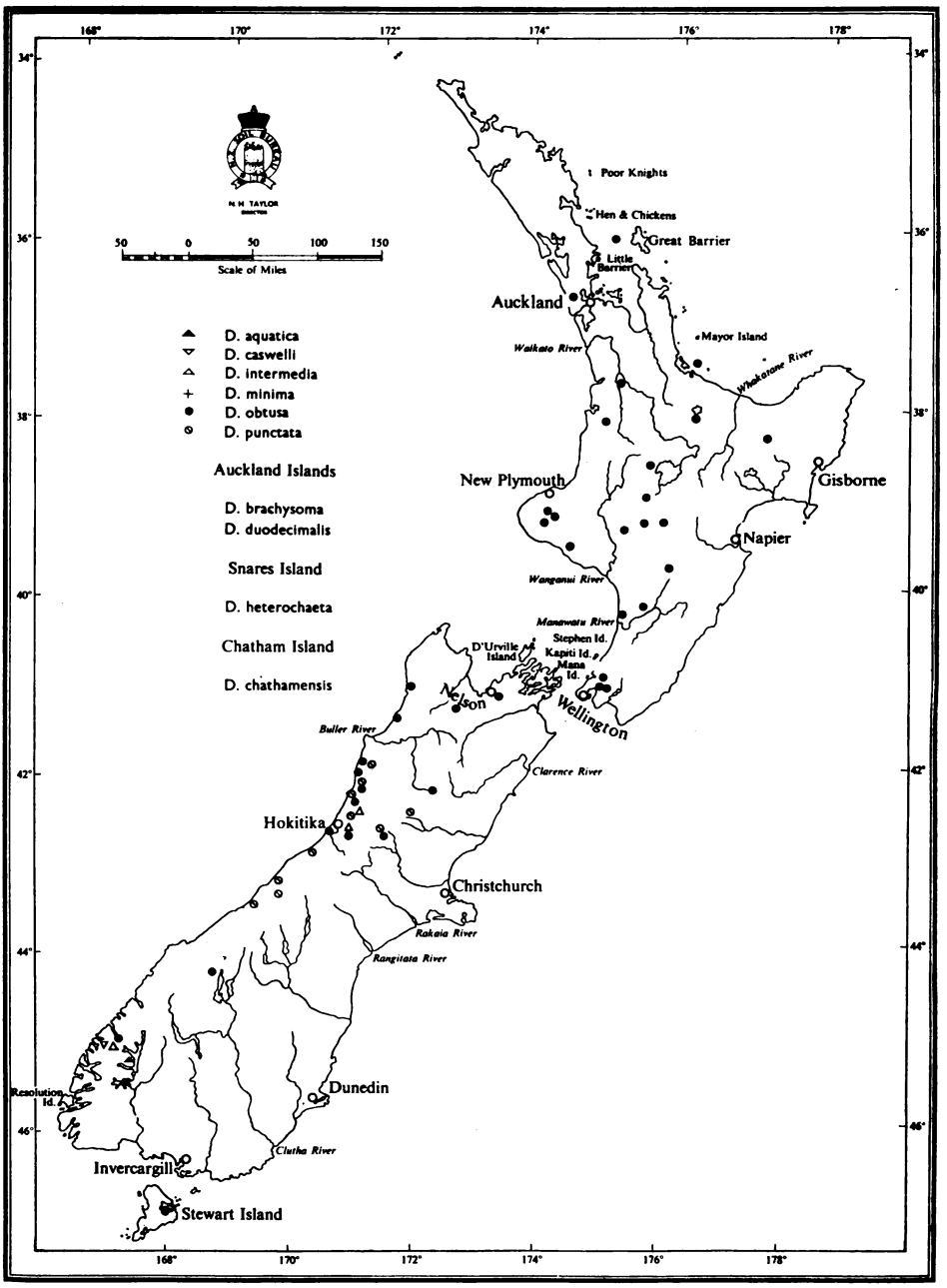

FIG. 364. Distribution of the New Zealand species of the genus *Diporochaeta*

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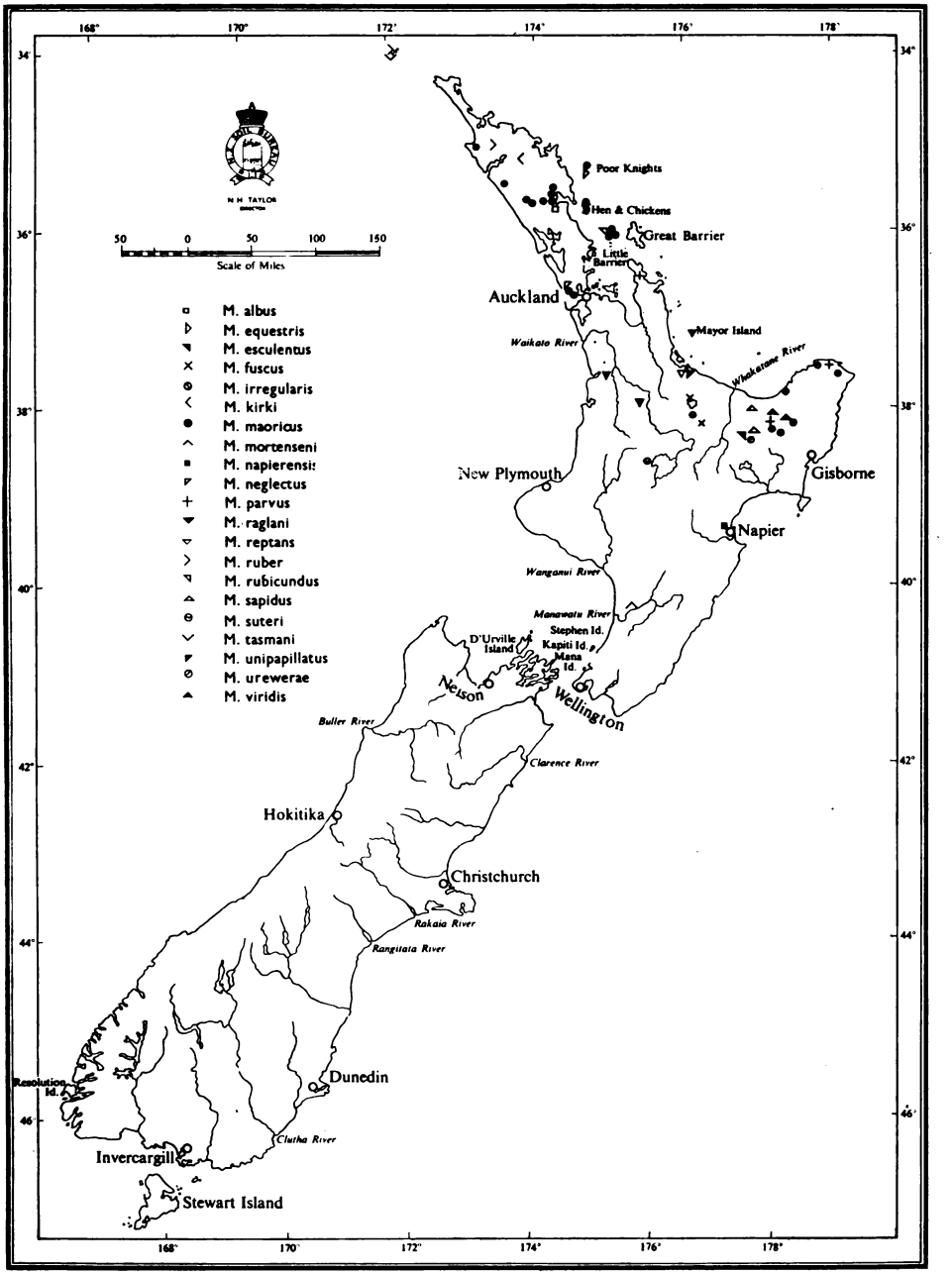

FIG. 365. Distribution of the New Zealand species of the genus *Megascolides*

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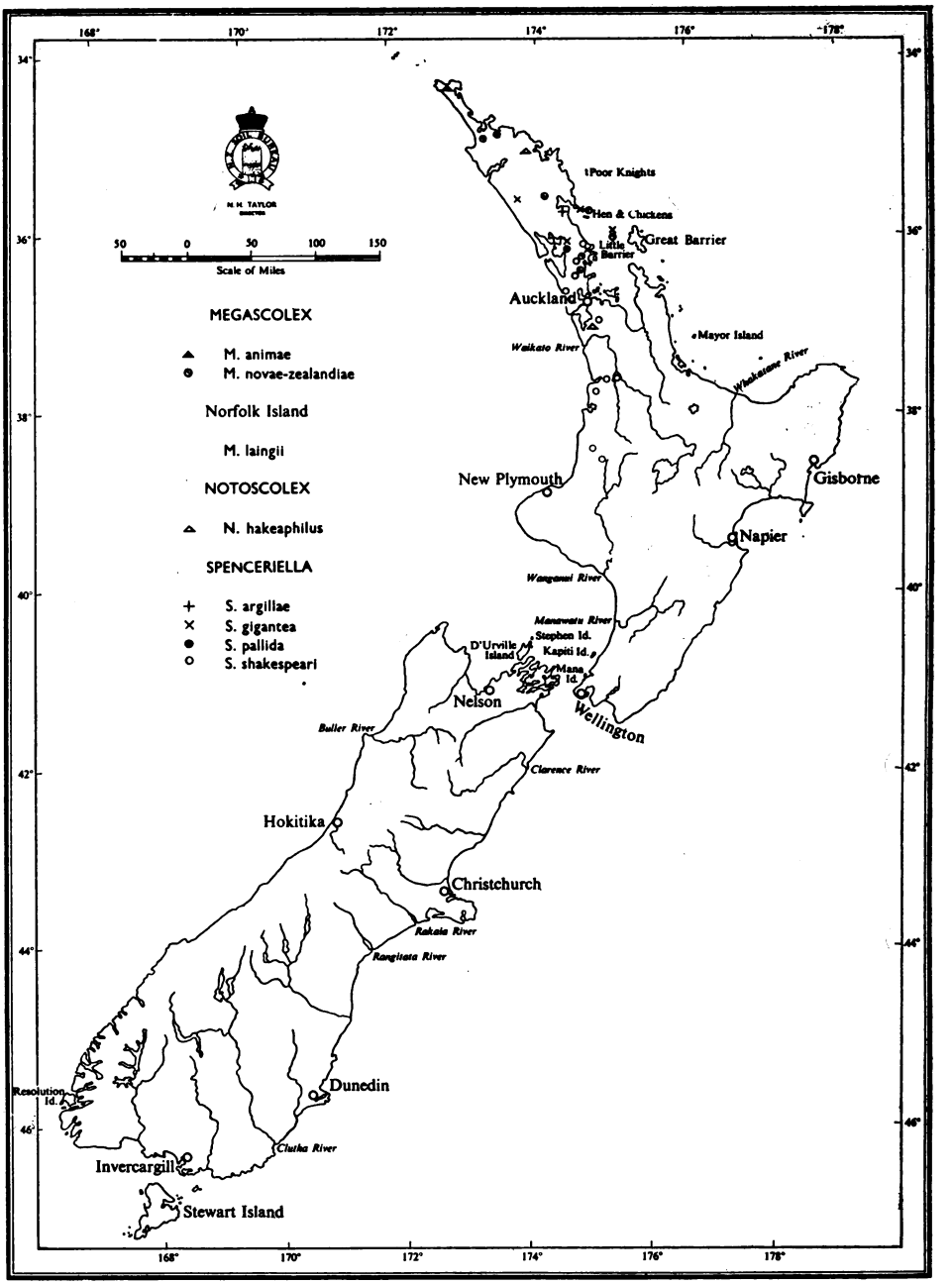

FIG. 366. Distribution of the New Zealand species of the genera *Megascolex*, *Notoscolex*, and *Spenceriella*

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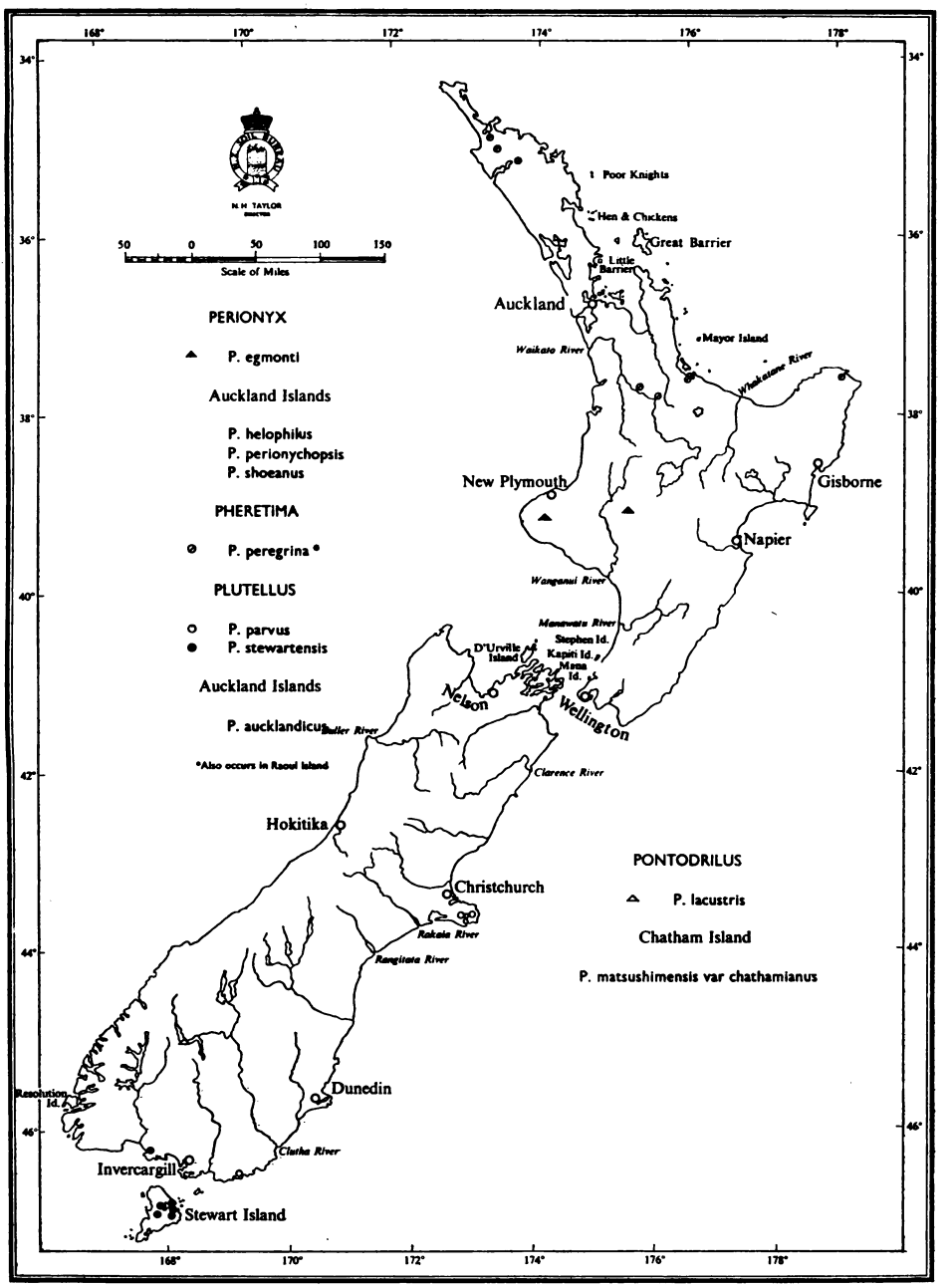

FIG. 367. Distribution of the New Zealand species of the genera *Perionyx*, *Pheretima*, *Plutellus*, and *Pontodrilus*

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Part Three

DISTRIBUTION AND RELATIONSHIPS OF INDIGENOUS EARTHWORMS

Discussion of earthworm distribution is confined to the indigenous section of the New Zealand fauna, and excludes exotic species. Although there are only fourteen species of exotic Lumbricidae known from New Zealand, representatives of this family are almost invariably present in pasture and cultivated soils, where they usually entirely replace any indigenous species which were present before the native vegetation was removed. Since a large proportion of the area of New Zealand has been cleared of its original vegetation since the country was occupied by Europeans, lumbricids now make up most of the earthworm fauna. Lumbricids appear to have been introduced at so many places and have become so well acclimatised, that there is no discernible relationship between their present distribution and geographical barriers, which are significant in the distribution patterns of indigenous earthworms and other groups of animals. Their distribution is to some extent related to ecological factors and to agricultural practices, and is discussed later in this work (see section on ecology, p. 442).

MEANS OF DISPERSAL OF EARTHWORMS

Animals may spread out and become distributed over an area in a number of ways. Population pressure, shortage of food or changing environmental conditions may force them to move outwards from a centre of population, or they may be carried by stream or ocean currents, on the wind, or adhering to other animals, and be deposited in new territory.

The ability of earthworms to spread by their own efforts over large continuous areas is frequently restricted by the highly specialised habitat preferences of species and the consequent need for continuity of an almost uniform environment to facilitate their spread. However, slow spread by their own efforts must have been mainly responsible for the dispersal of earthworms from original points of entry into the New Zealand mainland. In the process of spreading, closely defined habitat preferences have become established and, associated with them, physiological and morphological specialisation have been responsible for the establishment of distinct species.

Some species of earthworms emerge from their burrows at night and move freely about on the surface or in the leaf mould on the forest floor. Species that inhabit leaf mould have no burrows in the normally accepted sense of the word and wander in search of food. Such species readily spread through areas that have sufficiently similar environmental conditions for their survival, and may cover large areas.

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Some New Zealand species, which are apparently able to tolerate a wider range of environmental conditions than is common among earthworms, have become widespread in areas that, until comparatively recently, must have been uninhabitable to earthworms. *Octochaetus multiporus* is such a species. It is found in the North Island from about the Manawatu Gorge southward, and is common in all South Island districts east of the main dividing ranges and in Stewart Island. Much of this area, particularly in the South Island, must have been uninhabitable for earthworms at the last glacial maximum (see later discussion, p. 407, of area F, Fig. 368), and would have been repopulated only recently. *O. multiporus* is a large species that lives in the subsoil, where it makes extensive burrow systems, and apparently subsists on organic matter included in the soil, rarely coming to the surface. It is unlikely that it would be passively transported over large distances, and probable that it has achieved its distribution by its own efforts.

Most, if not all, earthworms can live for some time in fresh water. Some are commonly found living in streams, lakes, and swamps (see p. 418 for discussion of earthworm habitats), and a few seem to be confined to fresh water. Such species could, without difficulty, be dispersed throughout a river or lake system, either by their own efforts or with the assistance of currents. Terrestrial species, particularly those that live close to the ground surface or in dead logs, could easily be transported down streams during floods, and provided conditions are suitable for their existence where they are eventually stranded, could establish a new colony.

A few species of earthworms, which are euryhaline and live in the intertidal zone or in brackish water (see list of species, p. 424), have apparently been transported with drifting material by ocean currents. The importance of ocean currents in the dispersal of earthworms has been underestimated by most authors in the past. Stephenson (1930, p. 612) quoted Darwin, who stated that sea water killed earthworms very quickly. This is apparently true of species of Lumbricidae with which Darwin was familiar, but is not true of some species of Megascolecidae from the New Zealand region. Michaelsen (1911) was first to point out the existence of euryhaline species in the earthworm fauna of subantarctic islands, and the significance of this fact is further discussed in the present work.

Wind cannot be of any importance in moving earthworms from place to place. Neither adult worms nor cocoons would easily become airborne since they have not suitable aerodynamic form, although the cocoons might in exceptional circumstances be swept along the ground. The cocoons of most species are deposited beneath the ground surface, so would not normally be exposed to the wind.

Stephenson (1930, p. 660) mentions the possibility of the transport of cocoons and even small worms in mud on the feet of wading birds as a means of distributing small aquatic worms from one river or lake system to another. Subantarctic island species that live on or adjacent to the shore may also have been distributed on the feet of birds from one island to another. Terrestrial species, especially those

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that live in leaf mould and topsoil, are captured by birds, which, when feeding their young, carry them alive to the nest. Birds are occasionally seen to drop food when in flight, and living earthworms dropped in this way probably survive and may thus establish themselves in new territory. It is not suggested that worms are carried great distances in this way, but such methods of transport may be important in enabling a species to cross fast-flowing streams and narrow straits between the mainland coast and off-shore islands, or to become established in isolated small areas of forest, such as are found on pumice soils (in area D, Fig. 368).

DISTRIBUTION OF INDIGENOUS EARTHWORMS WITHIN THE NEW ZEALAND REGION

The New Zealand region is taken to mean the mainland of New Zealand (including North, South, and Stewart islands with their associated off-shore islands), Kermadec Islands, and Norfolk Island to the north, Chatham Islands to the east, and Snares, Auckland, Campbell, Macquarie, and Antipodes islands to the south of the mainland.

Two subfamilies of the family Megascolecidae are recognised in the indigenous New Zealand earthworm fauna. The subfamilies have dissimilar distribution patterns, the Acanthodrilinae being distributed throughout the region, while the Megascolecinae are confined almost entirely to northern and western districts of the mainland.

Nine faunal areas within the mainland and its off-shore islands may be recognised from the present distribution of megascolecid earthworms. The approximate boundaries of the nine areas are shown in the accompanying map (Fig. 368).

Kermadec Islands, Norfolk Island, Chatham Islands and Snares Island are regarded as distinct faunal areas, while Auckland, Campbell, Macquarie, and Antipodes islands are grouped together as a subantarctic islands area. (See inset, Fig. 368, for position of these islands).

The following is a list of the areas with a list of species and some discussion of the relationships of species recorded from each area.

AREA A. (Fig. 368)

Three Kings Islands; North Auckland Peninsula; western and central districts of the North Island, bounded on the east and south by soils derived from the recent Taupo ash shower (area D) and by a line running eastward from about Awakino to the western boundary of area D; Coromandel Peninsula; coastal Bay of Plenty. The recent Kaharoa ash shower extends through area A to the Bay of Plenty coast from about Tauranga to Whakatane. This area is included in area D, and isolates a small portion of area A, east of Whakatane, from the remainder. A considerable number of off-shore islands lie close to the coasts and are included in area A.

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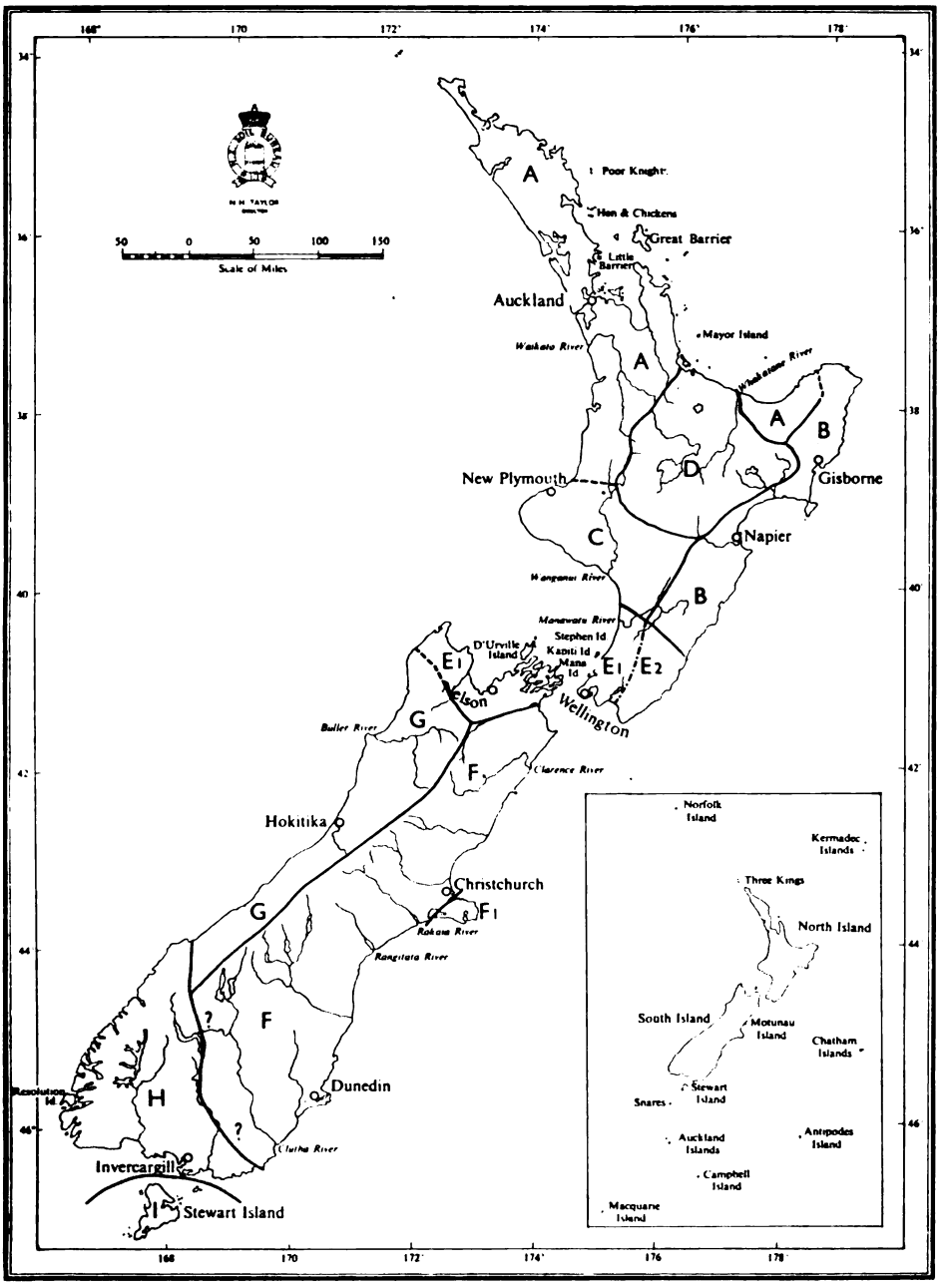

FIG. 368. Faunal areas of the New Zealand mainland, based on the distribution of Megascolecidae

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The area is characterised by the large number of species (46) and the large number of localised endemic forms; 39 of the 46 species are restricted to area A. Species present are:

Subfamily Acanthodrilinae

Deinodrilus lateralis
D. parvus
D. suteri
Dinodriloides beddardi
Hoplochaetina pallida
H. polycystis
H. robusta
H. spirilla
H. subtilis
Maoridrilus plumbeus
Rhododrilus aduncocystis
R. agathis
R. attenuatus
R. benhami (C)
R. insularis
R. macroseptus
R. parvus
R. ravus
R. similis (B, C, D)
R. sutherlandi
R tetratheca

Subfamily Megascolecinae

Diporochaeta obtusa (C, D, E, F, G, H, I)
Megascolex animae
M. novae-zealandiae
Megascolides albus
M. equestris
M. fuscus (D)
M. irregularis
M. kirki
M. maoricus
M. neglectus
M. parvus
M. raglani
M. reptans
M. ruber
M. rubicundus
M. suteri (B, D)
M. tasmani
M. unipapillatus
M. urewerae (D)
M. viridis (B)
Notoscolex hakeaphilus
Spenceriella argillae
S. gigantea
S. pallida
S. shakespeari

(Letters in brackets after the name of a species denote that that species is also found outside area A, in the area or areas designated by the letters).

Five groups of species are recognisable within the fauna of area A, as follows:

1. A large group of Megascolecine species (25), dominated by the genus *Megascolides* (17 spp.). One of these, *Diporochaeta obtusa,* is widely distributed outside area A. Four species of *Megascolides* occur outside, as well as within, area A, but only in areas adjacent to area A and close to the boundaries of area A. *Notoscolex hakeaphilus* may have been introduced from outside New Zealand. The genera *Megascolex* and *Spenceriella* in New Zealand are entirely confined to area A, and *Megascolides* is almost entirely confined to it.

2. Species of *Deinodrilus* and *Hoplochaetina,* which are closely related to species from western and south-western North and South Island districts.

3. A large group of species of *Rhododrilus* (11 species). These are closely related to species from area B.

4. *Maoridrilus plumbeus,* which is known only from the southern portion of area A and is related to species of *Maoridrilus* from areas C and E.

5. *Dinodriloides beddardi,* the only species of its genus, which is related to *Rhododrilus.*

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Earthworms have been recorded from Three Kings, Poor Knights, Hen and Chickens, Little Barrier, and Mayor islands in area A. (See Fig. 368 for location of islands.)

Three Kings Islands: This group consists of three main islands and a number of rocks. The largest, Great Island, is about two miles square. The islands lie about 35 miles N.W. of Cape Reinga, north of the North Island.

Species present are:

Subfamily Acanthodrilinae

Rhododrilus insularis — *R. tetratheca*
R. ravus

Subfamily Megascolecinae

Megascolides ruber — *M. tasmani*

All the species are confined to the islands except *M. ruber,* which is fairly common in the north of area A. The constitution of the fauna is similar to that of the North Auckland peninsula, but of all the off-shore islands studied in area A, the Three Kings fauna shows the highest degree of endemism. This could be taken as an indication that these islands have been separated from the mainland for longer than others, but the Three Kings Islands are 35 miles from the coast, and it is common in area A for localities so far apart, even in a continuous land area, to have widely different earthworm faunas.

Poor Knights Islands: This group consists of two main islands, one about 2½ miles long and ½ mile wide, the other about 1 mile long and ½ mile wide. They are about 16 miles east of the North Auckland coast, opposite Whananaki.

Species present are:

Subfamily Acanthodrilinae

Hoplochaetina pallida

Subfamily Megascolecinae

Megascolides equestris
M. suteri

Only one species, *M. equestris,* is peculiar to the islands. The other two species are common on the mainland adjacent to the islands.

Hen and Chickens Islands: The group consists of four islands, Hen Island (Taranga), about 2½ miles long and 1 mile wide, which lies about 9 miles south-east of Bream Head (near Whangarei), and Chicken Islands, ranging in area from about ¼ square mile to about 1 square mile, which lie about 4 miles north of Hen Island. Earthworms have been collected from Hen, Inner Chick and Big Chick islands. There is little difference between the earthworm faunas of the three islands. The following species have been collected:

Subfamily Acanthodrilinae

Dinodriloides beddardi — *Hoplochaetina subtilis*

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Subfamily Megascolecinae

Megascolides irregularis
M. maoricus
Spenceriella gigantea
S. shakespeari

All these species are also found on the mainland adjacent to Hen and Chickens islands and all but *H. subtilis* also on Little Barrier Island.

Little Barrier Island: This island is about 4 miles square, and lies 16 miles east of Cape Rodney, near Leigh, and 45 miles north-north-east of Auckland. The following species are present:

Subfamily Acanthodrilinae

Dinodriloides beddardi
Rhododrilus similis
R. parvus

Subfamily Megascolecinae

Megascolides irregularis
M. maoricus
M. rubicundus
M. suteri
Diporochaeta obtusa
Spenceriella gigantea
S. shakespeari

Only two species, *Rhododrilus parvus* and *Megascolides rubicundus,* are confined to Little Barrier Island, and all the others are common on the mainland. The island provides the northernmost records of *Diporochaeta obtusa* and *Rhododrilus similis,* which are widespread in areas to the south.

Mayor Island: This island lies 26 miles east of Coromandel Peninsula in Bay of Plenty, opposite Waihi. It is about 3 miles long and 2½ miles wide. Species recorded are:

Subfamily Megascolecinae

Diporochaeta obtusa
Megascolides reptans

Neither of the species is confined to Mayor Island. *D. obtusa* is very common on the mainland south of the island, while *M. reptans* has been recorded previously from Tauranga, on the mainland near Mayor Island.

The earthworms found on off-shore islands included in area A are identical with or closely related to those of adjacent mainland areas. The degree of endemicity exhibited by these island faunas is in general related to the distance of the islands from the mainland. Islands close to the shore have apparently only very recently become separated from the mainland, and there has been insufficient time for local speciation to occur. The Three Kings fauna is largely endemic, but this might be a result of the wider separation of the islands from the mainland, resulting in the isolation of faunas which were not closely similar when the separation became effective, and not necessarily an indication that the Three Kings Islands have been isolated from the mainland for a longer time than other islands closer to the mainland, where little or no difference in the fauna would have existed at the time of separation.

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AREA B. (Fig. 368)

The eastern portion of the North Island, from about Cape Runaway to a line running south-eastward to the east coast from about the Manawatu Gorge, bounded on the west by the main mountain chain of the North Island and the eastern boundary of the Taupo ash shower.

This area is characterised by the small number of species present (15), and the dominance of Acanthodrilinae. Species present are:

Subfamily Acanthodrilinae

Leucodrilus digitocystis
L. fuscus
L. robustus
Octochaetus sylvestris (C)
Rhododrilus albidus (C, D, E_2)
R. disparatus
R. microgaster
R. minimus
R. papaensis
R. robustus (D)
R. rosae
R. similis (A, C, D)

Subfamily Megascolecinae

Megascolides suteri (A, D)
M. viridis (A)
M. napierensis

Four distinct groups of species are recognisable, as follows:

1. *Megascolides suteri* and *M. viridis* are found only in the extreme north of area B, adjacent to area A. Both species are also known from area A.

2. *Leucodrilus digitocystis, L. fuscus, L. robustus, Rhododrilus disparatus, R. microgaster, R. minimus, R. papaensis,* and *R. rosae,* all endemic to area B. *R. disparatus* closely resembles *Leucodrilus* and in some respects is intermediate between *Rhododrilus* and *Leucodrilus.* The occurrence of *R. disparatus* within the portion of area B occupied by *Leucodrilus* lends further support to the close relationship indicated by its morphological similarity to *Leucodrilus.*

3. *Octochaetus sylvestris, Rhododrilus albidus, R. robustus* and *R. similis,* which are found in the southern portion of area B and in the adjacent areas C, D, and E_2.

4. *Megascolides napierensis,* which has been recorded only once, from a nurseryman's glasshouse, and is almost certainly introduced. This species has not been recorded outside New Zealand, but it has probably come from Australia or Indo-Malaya, where the genus is most common.

AREA C. (Fig. 368)

Taranaki, Rangitikei, and Manawatu districts in the west of the North Island, bounded on the north by the southern boundary of area A and soils formed from the Taupo ash shower, on the east by the main ranges of the North Island, and on the south by a line running to the west coast from the vicinity of Manawatu Gorge.

The fauna of this area is characterised by the small number of species (15), and the dominance of Acanthodrilinae. The boundary between areas A and C (broken line in Fig. 368) is not well defined. Megascolecinae predominate in area A, and Acanthodrilinae in area C,

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but there is no definite boundary line between the faunas of the two areas. Species present in area C are:

Subfamily Acanthodrilinae

Deinodrilus montanus (E_1, E_2)
Eodrilus micros
Hoplochaetina rubra
Octochaetus brucei
O. sylvestris (B)
O. tricystis
Rhododrilus albidus (B, D, E_2)
R. benhami (A)
R intermedius
R. similis (A, B, D)
Maoridrilus gravus (E_2)
M. rubicundus
Neodrilus edwardsi

Subfamily Megascolecinae

Diporochaeta obtusa (A, D, E, F, G, H, I)
Perionyx egmonti

Three groups of species are recognisable:

1. *Deinodrilus montanus, Octochaetus brucei, O. sylvestris, O. tricystis, Maoridrilus gravus, M. rubicundus,* and *Neodrilus edwardsi,* which are also found in area E or are closely related to species found in area E.

2. *Rhododrilus albidus, R. benhami, R. intermedius, and R. similis,* which have their closest affinities with the fauna of area B.

3. *Eodrilus micros, Hoplochaetina rubra,* and *Perionyx egmonti,* which are more closely related to south-western South Island and subantarctic island species than to the fauna of any other North Island area.

Diporochaeta obtusa is so widespread in New Zealand that it has been excluded from the three groups of species. Its distribution is discussed later in this work.

AREA D. (Fig. 368)

The central North Island area in which the soils are derived from the recent, rhyolitic, Taupo and Kaharoa ash showers of pumice sand and gravel.

Species present are:–

Subfamily Acanthodrilinae

Deinodrilus agilis
Rhododrilus aduncocystis (A)
R. albidus (B, C, E_2)
R. besti
Rhododrilus edulis
R. robustus (B)
R. similis (A, B, C)
Neochaeta salmoni

Subfamily Megascolecinae

Diporochaeta obtusa (A, C, E, F, G, H, I)
Megascolides esculentus
M. fuscus (A)
M. sapidus
M. suteri (A, B)
M. urewerae (A)

Two groups of species may be distinguished:

1. *Rhododrilus aduncocystis, R. albidus, R. robustus, R. similis, Diporochaeta obtusa,* and *Megascolides suteri,* characterised by their very wide distribution within area D and their widespread occurrence in areas surrounding area D. One or more species of this group is

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almost invariably found among earthworms collected from any locality within area D.

2. *Deinodrilus agilis, Rhododrilus besti, R. edulis, Neochaeta salmoni, Megascolides esculentus, M. fuscus, M. sapidus,* and *M. urewerae,* which are found distributed over small areas, some having been recorded only once, scattered around the extreme edges of area D. They are all found in areas outside area D or are very closely related to species from adjacent areas.

AREA E. (Fig. 368)

The southern portion of the North Island, south of areas B and C, the north-western portion of the South Island, bounded by the Wairau Valley and a line running north-west from near the head of the Wairau Valley to the west coast. The area includes Kapiti Island, Mana Island, and islands near the northern coast of the South Island. Two sub-areas, E_1 and E_2, are recognised. E_2 includes that portion of the area east of a line running southwards from about the Manawatu Gorge along the eastern side of the Tararua Ranges, the eastern side of the Ruamahanga River Valley, to Palliser Bay; E_1 includes the remainder of the area.

Twenty-six species are known from area E. Of these, 19 are restricted to the area. Only 2 species of Megascolecinae, *Diporochaeta obtusa* and *Megascolides mortenseni,* are known and the fauna is dominated by the acanthodriline genera *Maoridrilus, Neodrilus, Neochaeta,* and *Octochaetus.* Species present are:

Subfamily Acanthodrilinae

Deinodrilus gracilis
D. montanus (C)
Eodrilus pallidus
Hoplochaetina durvilleana
Octochaetus kapitiensis
O. michaelseni
O. multiporus (F, I)
O. pelorus
Rhododrilus albidus (B, C, D)
R. subtilis
Maoridrilus carnosus
M. gravus (C)
M. megacystis
M. minor
M. montanus
M. nelsoni
M. pallidus
M. ruber
M. tetragonurus
M. volutus
Neodrilus agilis
N. dissimilis
N. polycystis
Neochaeta forsteri (F)

Subfamily Megascolecinae

Diporochaeta obtusa (A, C, D, F, G, H, I)
Megascolides mortenseni

Six species, *Octochaetus multiporus, O. michaelseni, Rhododrilus albidus, Maoridrilus gravus, M. minor,* and *Neochaeta forsteri,* are known from sub-area E_2. Of these, only *O. multiporus* and *O. michaelseni* occur also in sub-area E_1, while *R. albidus* is found in areas B, C and D, *M. gravus* in area C, *N. forsteri* in area F, and only *M. minor* is peculiar to the sub-area. The fauna of the sub-area is transitional between the faunas of the areas surrounding it, and has probably derived most of its species fairly recently from the surrounding areas. (See later discussion of sub-area E_2.)

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Sub-area E_1 extends across Cook Strait, and no sharp distinction exists between the sections of the sub-area in the North and South islands. It is regarded as a centre of dispersal for the neodrilacean genera *Maoridrilus* and *Neodrilus*, and from it have probably been derived most of the species of *Maoridrilus* now found in other North and South Island areas. *Deinodrilus gracilis* is found in the Motueka district in the South Island, on Stephen Island, Kapiti Island, and on the North Island mainland adjacent to Kapiti Island. *Maoridrilus ruber* is found in the Wellington district, on Kapiti Island, Mana Island, and Stephen Island. *Octochaetus multiporus* is found throughout sub-area E_1, and also in areas E_2, F, H, and I. The very widespread species *Diporochaeta obtusa* also occurs in sub-area E_1. The remaining species are restricted in their distribution, but close relationships exist between species of the same genus within the area. *Megascolides mortenseni* has been recorded only once, from garden soil in Palmerston North, and is almost certainly an introduction. It has probably been introduced with plants from overseas, in which case it would be most likely to have come from Australia or Indo-Malaya.

OFF-SHORE ISLANDS

Earthworms have been recorded from Kapiti, Mana, Stephen, and D'Urville islands in area E_1 (Fig. 368).

Kapiti Island: This island is 6 miles long and 1½ miles wide and lies with its long axis parallel to the west coast of the North Island, 3½ miles west of Paraparaumu, near Wellington. Species collected from the island are:

Subfamily Acanthodrilinae

Deinodrilus gracilis
Octochaetus kapitiensis
O. multiporus
Rhododrilus subtilis
Maoridrilus ruber
M. volutus
Neodrilus dissimilis

The fauna consists entirely of Acanthodrilinae. Four species, *O. kapitiensis*, *R. subtilis*, *M. volutus*, and *N. dissimilis*, are confined to the island, while *D. gracilis* is also found in the North Island, Stephen Island, and the South Island adjacent to Cook Strait, *O. multiporus* occurs in areas E_1, E_2, F, and I on the mainland, and *M. ruber* is found in the Wellington district and on Mana and Stephen Islands.

Mana Island: Mana Island is 2 miles west of Titahi Bay and 14 miles south of Kapiti Island; it is about 1½ miles long and ¾ mile wide, with its long axis parallel to the mainland coast. Only two species of earthworms, *Maoridrilus carnosus* and *Maoridrilus ruber*, are known from the island. Both of these species are found on the North Island mainland adjacent to Mana Island.

D'Urville Island: This is a fairly large island, about 19 miles long and 6 miles wide, situated north-west of the mouth of Pelorus Sound, and separated from the mainland by a very narrow strait. Unfortunately, little collecting has been done on this island and only one species, *Hoplochaetina durvilleana*, has been recorded. This species was described

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by Benham in 1919 and no collecting has been done on the island since then.

Stephen Island: This small island, about 1½ miles long and 1 mile wide, lies about 2½ miles north-east of the northernmost point of D'Urville Island. Species recorded from the island are:

Subfamily Acanthodrilinae

Deinodrilus gracilis	*M. ruber*
Maoridrilus megacystis	*M. tetragonurus*

Maoridrilus megacystis and *M. tetragonurus* are, so far as is known, confined to Stephen Island, but since the fauna of the adjacent D'Urville Island is not well known, the endemicity of these two species is doubtful. *Deinodrilus gracilis* is well known from adjacent North and South Island areas and from Kapiti Island, and *M. ruber* is known from North Island, Kapiti Island and Mana Island localities.

AREA F. (Fig. 368)

The eastern portion of the South Island from about the Wairau River in the north, bounded on the west by the main mountain chain of the South Island, and on the south by a line (not well determined) running from somewhere in the vicinity of Lake Wakatipu to the coast east of Invercargill.

The fauna is dominated by Acanthodrilinae, of which there are 22 species out of a total of 25. Species present are:

Subfamily Acanthodrilinae

Eodrilus annectens	*M. modestus*
E. montanus	*M. parkeri*
E. paludosus	*M. purus*
Octochaetus antarcticus	*M. smithi*
O. huttoni (H, I)	*M. suteri*
O. multiporus (E, I)	*M. uliginosus*
O. thomasi (G, H)	*M. ultimus*
Rhododrilus cockaynei (Subantarctic islands)	*M. wilkini*
	Neochaeta forsteri (E_2)
R. minutus	*Neodrilus campestris*
Maoridrilus alpinus	*Plagiochaeta sylvestris* (G, H)
M. dissimilis	

Subfamily Megascolecinae

Diporochaeta obtusa (A, C, D, E, G, H, I)	*D. punctata* (G)
	Plutellus parvus

Area F is very large, more than twice the size of area A, but there are only 25 species of earthworms, whereas area A has 47. Area F is characterised by the very wide range of individual species; *E. paludosus, O. multiporus, M. dissimilis, M. modestus, M. uliginosus* and *N. forsteri* are very widely distributed. Another feature is the large number of species of *Maoridrilus* (10) and the fact that all these species are confined to area F. *Rhododrilus cockaynei,* which has been found in a saline marsh close to Dunedin, is the only species known from subantarctic islands that has been found on the New Zealand mainland. It is known to inhabit the intertidal zone on the shores of subantarctic islands and has probably been dispersed by rafting. A

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small sub-area, F_1, may be distinguished, including Banks Peninsula. Species characteristic of this area are *Rhododrilus minutus, Maoridrilus modestus, M. purus, Octochaetus multiporus,* and *Plutellus parvus.*

OFF-SHORE ISLANDS

There are few off-shore islands adjacent to this area, and earthworms have been collected from only one.

Motunau Island (Fig. 368): This is a small island, about ¼ mile square, situated about ¼ mile east of the Canterbury coast, opposite the mouth of the Motunau Stream. Only one specimen, of *Octochaetus multiporus,* has been collected from the island. The specimen was lying on the ground surface and was dead when found, and it is possible that it was carried from the mainland and dropped by a sea bird.

AREA G. (Fig. 368)

The western portion of the South Island, bounded on the north by the boundary of area E_1, on the east by the main mountain ranges of the South Island, and on the south by a line running inland from about Jackson Bay.

The fauna includes only 16 species and is dominated by Acanthodrilinae (13 species). Species present are:

Subfamily Acanthodrilinae

Decachaetus minor
Deinodrilus kanieriensis
Eodrilus rossi
Eudinodriloides forsteri
Octochaetus ravus
O. thomasi (F, H)
Rhododrilus dobsoni
Sylvodrilus gravus
Maoridrilus fuscus
M. michaelseni
M. transalpinus (H)
Plagiochaeta lineata (H)
P. sylvestris (F, H)

Subfamily Megascolecinae

Diporochaeta intermedia (H)
D. punctata (F)
D. obtusa (A, C, D, E, F, H, I)

Three groups of species are recognisable:

1. *Deinodrilus kanieriensis, Octochaetus ravus, Maoridrilus fuscus,* and *M. michaelseni,* which, although confined to area G, are closely related to species in area E.

2. *Decachaetus minor, Eodrilus rossi, Octochaetus thomasi, Maoridrilus transalpinus, Plagiochaeta lineata, P. sylvestris,* and *Diporochaeta intermedia,* which are also found in, or are closely related to species from, areas H and I.

3. *Eudinodriloides forsteri* and *Sylvodrilus gravus,* which represent monotypic genera and are restricted to the area, but are related at the generic level to southern forms, particularly to *Microscolex.*

Diporochaeta obtusa, D. punctata, and *Rhododrilus dobsoni* are not included in this grouping. *D. obtusa* is found throughout most of the mainland of New Zealand, *D. punctata* is closely related to *D. obtusa,* but has a more restricted distribution, and *R. dobsoni* is an isolated representative of *Rhododrilus,* probably a relic of a former, wider distribution of the genus.

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AREA H. (Fig. 368)

The south-western portion of the South Island, west of a line from about Jackson Bay to the coast east of Invercargill. The fauna consists of 19 species, of which 13 are Acanthodrilinae and 6 are Megascolecinae. Species present are:

Subfamily Acanthodrilinae

Deinodrilus benhami
Eodrilus parvus
Hoplochaetina rossii
Octochaetus huttoni (F, I)
O. thomasi (F, G)
Perieodrilus lateralis
P. montanus
P. ricardi
Rhododrilus aquaticus
Maoridrilus transalpinus (G)
Plagiochaeta lineata (G)
P. stewartensis (I)
P. sylvestris (F, G)

Subfamily Megascolecinae

Diporochaeta aquatica
D. caswelli
D. intermedia (G)
D. obtusa (A, C, D, E, F, G, I)
Plutellus stewartensis (I)
Pontodrilus lacustris

The fauna of area H differs considerably from that of surrounding areas. The following groups of species are recognisable:

1. *Rhododrilus aquaticus, Diporochaeta aquatica,* and *Pontodrilus lacustris,* which are aquatic species. *R. aquaticus* is known from brackish water in Caswell Sound, and, in its ability to live in saline conditions, resembles *R. cockaynei,* from subantarctic islands. *D. aquatica* and *P. lacustris* are known from inland lakes in old glacier valleys. They must, therefore, have been derived from terrestrial ancestors, and have taken up a lacustrine existence recently. Species of *Pontodrilus* are usually found in the intertidal zone of seashores, and the presence of *P. lacustris* in an inland lake, far removed from any other representatives of *Pontodrilus,* is difficult to explain. The species is closely related in its morphology to *Plutellus parvus* and throws doubt on the validity of distinguishing at the generic level between the two species. The presence of megascolecid species that are apparently wholly aquatic is a feature peculiar to area H.

2. *Deinodrilus benhami* and *Hoplochaetina rossii,* which are closely related to species from the Cook Strait region (*D. gracilis* in the former case and *H. durvilleana* and *H. rubra* in the latter case), and to North Auckland species.

3. *Eodrilus parvus, Perieodrilus lateralis, P. montanus, P. ricardi, Rhododrilus aquaticus, Plagiochaeta lineata, P. stewartensis, P. sylvestris, Diporochaeta aquatica, D. intermedia, Plutellus stewartensis.* These species have their closest affinities with species to the south of area H. *Eodrilus parvus* and the three species of *Perieodrilus* are most closely related to Snares Islands species. *Perieodrilus* is found only on Snares Islands and in area H. *Rhododrilus aquaticus* is similar, morphologically and in its ecological preferences, to *R. cockaynei,* which is found on subantarctic islands. *Diporochaeta aquatica* and *D. intermedia* resemble *D. heterochaeta* from Snares Islands and *D. brachysoma* from Auckland Islands more closely than they resemble any mainland species. *Plutellus stewartensis* more closely resembles *P. aucklandicus,* from Auckland Islands, than it does *P. parvus,* from the mainland.

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The three species of *Plagiochaeta,* although all found outside area H, appear to be most common and widespread in area H, and may have radiated from there to achieve their present distribution.

4. *Octochaetus thomasi, O. huttoni, Maoridrilus transalpinus, Diporochaeta caswelli,* and *D. obtusa.* These species are common in one or more surrounding areas and are probably to be regarded as having originated outside area H. *D. caswelli,* which closely resembles *D. obtusa,* may be an exception and may have spread out from area H.

OFF-SHORE ISLANDS

Earthworms are known from only one off-shore island adjacent to area H.

Resolution Island (Fig. 368) : Situated between the mouths of Dusky and Breaksea sounds, at the extreme south-western tip of the South Island, this island is about 10 miles long and 10 miles wide. The only species recorded from this island is *Perieodrilus ricardi.* Benham's type specimen of the species came from Resolution Island. The species closely resembles *P. lateralis* and *P. montanus,* which are found on the mainland adjacent to Resolution Island.

AREA I. (Fig. 368)

Stewart Island.

Species present are:

Subfamily Acanthodrilinae

Decachaetus violaceus
Plagiochaeta stewartensis (H)
Octochaetus huttoni (F, H)
O. multiporus (E, F)

Subfamily Megascolecinae

Diporochaeta minima
D. obtusa (A, C, D, E, F, G, H)
Plutellus stewartensis (H)

The fauna of area I has much in common with that of area H, and might be regarded as part of area H. However, the presence of *O. multiporus* and *O. huttoni* indicates a close relationship to the fauna of area F. The area is regarded as having been continuous with areas F and H so recently that differentiation of species has not occurred since the areas became separated. *Decachaetus violaceus* and *Diporochaeta minima* are the only species confined to area I. The former closely resembles *Decachaetus minor,* from area G, while the latter is similar to the widespread species *Diporochaeta obtusa.*

SNARES ISLANDS. (Fig. 368)

These islands are situated 62 miles south of the south-west cape of Stewart Island. Species present are:

Subfamily Acanthodrilinae

Eodrilus fallax
E. haplocystis
Perieodrilus plunketi
Rhododrilus cockaynei

Subfamily Megascolecinae

Diporochaeta heterochaeta

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Rhododrilus cockaynei is found on a number of subantarctic islands and on the New Zealand mainland (southern coast of area F). It is euryhaline and is found in the intertidal zone, so it could have been dispersed by rafting. The remainder of the fauna is closely related to that of area H (see discussion under area H).

SUBANTARCTIC ISLANDS. (Fig. 368)

Under this heading are included Auckland, Campbell, Macquarie, and Antipodes islands. These islands are grouped as a single faunal area, since close relationships exist between the faunas of the various islands and island groups.

AUCKLAND ISLANDS

These islands are situated about 190 miles south of the south-west cape of Stewart Island. Species present are:

Subfamily Acanthodrilinae

Microscolex aucklandicus
M. campbellianus
Rhododrilus cockaynei
R. leptomerus

Subfamily Megascolecinae

Diporochaeta brachysoma
D. duodecimalis
Plutellus aucklandicus
Perionyx helophilus
P. perionychopsis
P. shoeanus

The fauna of these islands presents a puzzling feature, in that, alone of the subantarctic islands, it has representatives of the genus *Perionyx*, which is known from the New Zealand mainland only near Mt. Egmont (*P. egmonti*). The genus is otherwise known from India, Ceylon, and Australia. It is unlikely that these species have been introduced, but since an attempt was once made to farm the islands and a settlement was established, it is not impossible that they were. If they were introduced their origin was probably not New Zealand and would probably have been some tropical or near tropical area. It is unlikely that tropical species would survive in subantarctic island peat soils and it therefore seems most likely that the species are indigenous. If they are indigenous I cannot adequately explain how they might have become established on the Auckland Islands. The distribution of the genus is similar to that of *Hoplochaetina* and *Deinodrilus*, except that species are found in the Auckland Islands instead of the south-west of the South Island.

Among the remaining seven species, two groups are recognisable, as follows:

1. *Microscolex aucklandicus* and *M. campbellianus*. These two species are closely related to a number of species of *Microscolex* from South America, South Africa, Kerguelen Island, Crozet Islands, Macquarie Island, and Heard Island, and are not closely related to any New Zealand Megascolecidae.

2. *Rhododrilus cockaynei, R. leptomerus, Diporochaeta brachysoma, D. duodecimalis,* and *Plutellus aucklandicus*. These species are all closely related to New Zealand mainland species, especially to those of area H, and are considered to have been derived from area H. *R. cockaynei* and

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R. leptomerus are also found on Campbell Island and the former on Snares Islands and the mainland of New Zealand.

CAMPBELL ISLANDS

These islands are situated about 370 miles south of the south-west cape of Stewart Island. Species present are:

Subfamily Acanthodrilinae

Microscolex campbellianus — *Rhododrilus cockaynei*, *R. leptomerus*

The fauna of the Campbell Islands is characterised by the paucity of species and the absence of any species peculiar to the islands. *M. campbellianus* belongs to the circum-polar *Microscolex* group discussed previously, while the other two species are related more closely to New Zealand forms. All three species are euryhaline, have been collected from the shore or close to the shore, and are also known from Auckland Islands.

MACQUARIE ISLAND

Macquarie Island is situated about 600 miles south-west of the south-west cape of Stewart Island. Only one species of megascolecid, *Microscolex macquariensis*, is known from the island. It resembles *M. aucklandicus* and *M. campbellianus* and belongs to the circum-polar *Microscolex* group.

ANTIPODES ISLANDS

Only one species, *Microscolex aucklandicus*, has been recorded from this small island group, which is situated 490 miles east-south-east of the south-west cape of Stewart Island, about 12° east of the Auckland Islands and in about the same latitude. Rafting or chance transport by birds of cocoons or juvenile worms would account for the presence of the species.

CHATHAM ISLANDS

This group of islands is situated about 625 miles east of Banks Peninsula. Species present are:

Subfamily Acanthodrilinae

Rhododrilus huttoni

Subfamily Megascolecinae

Diporochaeta chathamensis — *Pontodrilus matsushimensis* var. *chathamianus*

The earthworm fauna of the Chatham Islands is remarkable for the small number of species present. *Diporochaeta chathamensis* is very closely related to *D. obtusa*, which is widely distributed on the mainland. *Rhododrilus huttoni* is also closely related to mainland species. *P. matsushimensis* var. *chathamianus* is a variety of an intertidal species which is widely distributed on the shores of Pacific Islands.

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RAOUL ISLAND

This island is the largest of the Kermadec group and is situated about 600 miles north-east of Auckland. Only two acanthodriline species, *Acanthodrilus kermadecensis* and *Rhododrilus kermadecensis* and one megascolecine species, *Pheretima peregrina,* are known from the island, although collections have been made on several occasions. *Pheretima peregrina* is undoubtedly introduced, but the two acanthodriline species appear to be endemic. *Acanthodrilus kermadecensis* is the only species of *Acanthodrilus* known from outside New Caledonia and the neighbouring island of Maré. *Rhododrilus kermadecensis* differs only slightly from a number of New Zealand species of the genus.

NORFOLK ISLAND

This island is situated about 600 miles north-west of Auckland. Only one megascolecid species, *Megascolex laingii,* has been recorded. It was described by Benham (1902) and has not been re-collected. Such of its anatomy as was described shows that it resembles *M. animae,* from the extreme north of New Zealand, and some Australian species.

DISCUSSION

Taking into account the faunas of all the areas listed, the most significant features of the pattern of distribution are as follows:

1. Acanthodrilinae and Megascolecinae are found in all areas on the mainland and on all but a few of the smallest islands.

2. A small group of megascolecine genera, including a large number of species, dominates the fauna of area A, and is almost completely confined to area A. This group comprises all the endemic species of *Megascolides, Megascolex* and *Spenceriella.* It is characterised by the large number of species and the small distributional range of individual species.

3. Area B has an earthworm fauna consisting almost entirely of Acanthodrilinae. Species of three genera, *Octochaetus, Rhododrilus,* and *Leucodrilus,* make up most of the fauna. *Leucodrilus* is confined to area B, but the other two genera are widely distributed and species of one or other may be found in every other area. Species of *Rhododrilus* from area B closely resemble some species from the north of area A.

4. Another group of genera, some acanthodriline and some megascolecine, is distributed in mainland districts west of the main dividing ranges and in the Snares and Auckland islands, and species of these genera are rarely found east of the main dividing ranges. Genera included in this group are *Decachaetus, Deinodrilus, Hoplochaetina, Perieodrilus, Plagiochaeta, Diporochaeta, Perionyx, Plutellus,* and *Pontodrilus.* Included in this group are a number of species from area H that have their closest affinities with species from Snares and Auckland islands. Two of the genera, *Hoplochaetina* and *Perionyx,*

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have unusual distribution patterns. The former occurs only in area H, D'Urville Island in area E, Mt. Egmont in area C, and the north of area A, while the latter is found only in Auckland Islands and in area C, on and near Mt. Egmont.

5. Area D, which is the area covered by the recent Taupo and Kaharoa ash showers, has a fauna dominated by a few species, each of which is widely distributed within area D and is known from one or more areas adjacent to area D.

6. *Maoridrilus, Neodrilus,* and *Neochaeta,* which are included in the tribe Neodrilacea, dominate the fauna of area E. Most of the species of these genera in area E have small distributional ranges, and in this respect resemble the Megascolecinae of area A. The distribution pattern of Neodrilacea in area E does not appear to have been modified in any way by the present position of Cook Strait.

7. In areas F, G, and I, individual species are usually widely distributed and the number of species, relative to the sizes of the areas, is much smaller than in all the areas to the north except area D.

8. Area H has a fauna that includes a few species similar to those of adjacent areas, but otherwise its fauna is more closely related to those of Snares and Auckland Islands.

9. The fauna of Snares Islands closely resembles that of area H.

10. The fauna of Auckland Islands has some species similar to those of area H, but includes some species of *Perionyx,* which otherwise occurs only in area C, and representatives of a group of species of *Microscolex,* which have a circum-polar distribution on islands in the southern ocean.

11. The fauna of Macquarie Island, Campbell Islands, and Antipodes Islands consists of a few, euryhaline species, some of which are shared with Auckland Islands and belong to the New Zealand genus *Rhododrilus,* while the remainder, all species of *Microscolex,* are closely related to a number of species from Kerguelen, Crozet and Falkland Islands, South America, and South Africa, and are not closely related to the New Zealand fauna, which does not include any endemic species of *Microscolex.*

12. Species found on Chatham Islands closely resemble species from the New Zealand mainland.

13. Of the two species known from Raoul Island, one has affinities with the fauna of New Zealand and the other with that of New Caledonia.

14. The fauna of off-shore islands generally closely resembles or is identical with that of the mainland adjacent to the particular island.

15. *Diporochaeta obtusa* is very widely distributed in North, South and Stewart Islands. It is found in every area except B and E_2 (i.e. eastern coastal districts of the North Island). No other species of New Zealand megascolecid is so widely distributed. It is a very small worm, found usually in forest leaf mould, but it has also been collected in the litter and topsoil under tussock, scrub or forest (native or exotic),

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under logs, stones, in moss and swamps. Such a wide range of habitats is not known in any other New Zealand megascolecid species. Because of their very small size, adult worms and their cocoons could easily be carried and dropped by birds. With its ability to tolerate a wide variety of environmental conditions, the species could readily become established in a new habitat. There are a number of other species of *Diporochaeta* in the New Zealand region that closely resemble *D. obtusa* in size, appearance, habits and anatomy, but none of them has such a wide distribution as *D. obtusa*. The species are *D. punctata* (area G and the western portion of area F), *D. caswelli* (area H), *D. duodecimalis* (Auckland Islands), *D. minima* (area I), *D. chathamensis* (Chatham Islands). A close study of the ecology of *D. obtusa* might reveal some characteristic that gives the species an advantage over others, but at present no reasonable explanation of its very widespread distribution can be given.

The most prominent break in the distribution pattern of New Zealand Megascolecidae is at the southern boundary of area A, where a fauna (in area A) dominated by *Megascolides* gives way to a fauna dominated by acanthodriline genera. Benham (1906a) recognised this, stating that as far as his observations had gone, the line separating a northern from a southern fauna coincides "in a most remarkable manner with the line recognised by Dr L. Cockayne separating a northern and more southern flora, that line being the parallel 38° S." Benham considered that this boundary was due to some kind of climatic barrier.

The central portion of the North Island, during Pleistocene and Recent times, has been subject to intense volcanic activity. Fleming (1949) places the great ignimbrite eruption, which covered much of the central North Island, in the lower Castlecliffian (early Pleistocene). The northern boundary of the ignimbrite is in the vicinity of the southern boundary of area A. It may be assumed that any vegetation and associated soil fauna that existed when the ignimbrite was deposited would have been destroyed. Since the ignimbrite was deposited there has been a succession of volcanic outbursts in the same part of the North Island, which has continued through to the present day. Some of the material deposited (e.g. the volcanic dust erupted from Ruapehu and Ngauruhoe in the last few years) has accumulated slowly without destroying the vegetation and the soil fauna, but showers of rhyolitic ash such as the Taupo and Kaharoa showers, which were hot when they fell and covered large areas to a considerable depth, destroyed and buried the vegetation. The effect of the series of volcanic outbursts, which has continued through the Pleistocene and Recent (see map in N.Z. Soil Bureau (1954)), has been to maintain a barrier between area A and areas to the south. The northern edge of the Taupo and Kaharoa showers, which were deposited only about 1,700 and 600 years ago respectively, defines most of the present southern boundary of area A. The Kaharoa shower extends to the coast between Tauranga and Whakatane and cuts off a portion of area A from the remainder (see Fig. 368).

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On the east, area A is bounded by the Raukumara Range, which extends north-eastward to East Cape. The boundary here is rather indefinite. Species of *Megascolides* are found on the eastern side of the range in area B (e.g. *Megascolides viridis,* at Motu), and species characteristic of area B (e.g. *Leucodrilus robustus*) are found on the Bay of Plenty coast, inside the boundary of area A. The south-west boundary of area A, adjoining area C, is not well defined. Before the great volcanic outbursts that have defined the present southern boundary of area A, it is likely that the sea covered much of the south of the North Island (see Fleming 1949) and confined the "*Megascolides* group" of earthworms to an area not much larger than they occupy now. Withdrawal of the sea has been followed by volcanic activity, and the "*Megascolides* group" may have been pushed further northward. The faunas of area A and area C merge somewhere in north Taranaki but there is no definite boundary.

Area B contains a fauna dominated by Acanthodrilinae, especially *Rhododrilus* and the related genus *Leucodrilus. Rhododrilus* is a genus belonging to the archaic New Zealand Acanthodrilinae. Its dominance in area B, and the almost complete absence of Megascolecinae, indicates that area B has been insulated from invasion by earthworms from area A for a long period of time, yet a close relationship exists between the Acanthodrilinae of area B and those of area A, indicating that they must, at some time, have had a continuously distributed acanthodriline fauna.

Area D is the area in which the parent material of the soils is Taupo or Kaharoa ash. These soils have been colonised by plants and soil fauna in the last 1,700 years in the case of the Taupo and about 600 years in the case of the Kaharoa soils. The coarse physical texture of the soils, and the discontinuous distribution of forest vegetation, have acted as a highly selective barrier to the dispersal of earthworms from surrounding areas into area D. Those species, particularly a few species of *Rhododrilus,* that have been able to adapt themselves to the environment provided by pumice soils have spread through the pumice country and achieved a very wide distribution. No species of Megascolecinae has become widely distributed in Taupo or Kaharoa pumice soils, although Megascolecinae are dominant in area A, which adjoins the pumice country. The wide distribution of *Rhododrilus albidus, R. robustus* and *R. similis* is the most striking feature of the earthworm fauna of area D.

Where the conditions prevailing in Taupo pumice have been modified, other earthworms, especially Megascolecinae, have become established. Examples are seen in the area covered by the Rotomahana mud, which has been deposited over the top of Taupo pumice, is of a finer texture than Taupo pumice, and differs in chemical composition, and in the pine forests that have been planted on Taupo pumice soils. In both of these cases, Megascolecinae have quickly become established and spread through the modified area.

Area C has a fauna with close relationships to the faunas of areas B and E, but differs from these areas in having species of *Perionyx* and *Hoplochaetina,* which ally it with the faunas of areas A and H. Forster

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(1954) found that a close relationship existed between the Opiliones of western South Island and west-central North Island districts. He attributed the similarity to the presence until recently of a land connection between North and South islands, which Te Punga (1953) considers to have extended from the north-western portion of the South Island, through D'Urville Island to the west coast of the North Island in the vicinity of Waikanae. Such a land connection would account for the very close relationship of earthworms in the North and South Island portions of area E_1, but the relationships of earthworms from area C to those of western South Island districts are not close enough to support a hypothesis of a very recent land connection extending southwards from area C. It seems more likely that all western districts of New Zealand have, at some more remote time, been populated by a group of earthworms, including the genera *Decachaetus, Deinodrilus, Hoplochaetina, Perieodrilus, Plagiochaeta, Diporochaeta, Perionyx, Plutellus,* and *Pontodrilus,* which may have belonged to the fauna of a former land mass to the west of the present New Zealand mainland. Remnants of this western fauna are still found in western districts of the North and South Islands and in the sub-antarctic islands, but in area C they now constitute a minor element of the fauna, and their affinities are not as obvious as those of other species in area C to species from the North Island portion of area E_1.

In areas A, B, C, and D, present earthworm distribution seems to have been determined very largely by the effects of volcanic activity and associated effects on the vegetation, changes in the distribution of land and sea, and the presence of a mountain barrier separating western and eastern areas. From area E southwards, the present pattern of distribution of earthworms appears to have arisen as a result of climatic and associated vegetational changes following Pleistocene glaciation, the presence of a mountain barrier between west and east and, in area E, the existence until recently of a land connection between the North and the South Islands.

Willett (1950, p. 33) mapped the area of New Zealand that he considered to have been covered by ice, and the associated vegetational pattern, during the maximum extension of ice in the Pleistocene. Willett considered that, in the North Island, ice would have covered only the highest parts of Mt. Egmont, the central volcanoes, Ruahine and Tararua Ranges. Periglacial conditions would have prevailed adjacent to the ice-covered high country, but most of the North Island would, in Willett's opinion, have been covered by *Nothofagus* forest. In the South Island, forest would have been confined to the extreme north, apart from small remnants that may have survived on Banks Peninsula, and close to sea level in such areas as Stewart Island, south-east Otago, north-west Nelson, and north Westland. The last (Mankato) glacial maximum, dated by the radio-carbon method (Flint and Deevey, 1950) was about 11,000 years ago. Te Punga (1953) considers that a land connection between North and South islands persisted until about 11,000 years ago, and Fleming (1949) considers that Stewart Island may have been connected to the mainland at glacial maxima. It is therefore apparent that the geographical relationships of the present

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distributional areas may be very different from those that prevailed in the recent past.

Area E is characterised by the dominance of the neodrilacean genera *Maoridrilus, Neodrilus*, and *Neochaeta*. That part of area E east of the Tararua ranges and the valley of the Ruamahanga River is differentiated as sub-area E_2. Fleming (1949), in an interpretation of the paleogeography of New Zealand in the early Wanganui (early Pliocene) epoch, showed the south-western portion of Wellington province (part of sub-area E_1) joined to what is now the northern portion of the South Island, the whole separated from what is now the eastern ranges of the Wairarapa district by a narrow strait. The eastern ranges of Wairarapa are shown as a large island, separated from another large island to the north (where the eastern hills of Hawke's Bay are now situated) by another, somewhat narrower, strait. Distinct faunas may be expected to have arisen in the isolated land areas during the period of their isolation, and as the North and South islands acquired their present form, it would be expected that the faunas already established on the islands would move out into the Wairarapa lowlands and mingle, giving a fauna with strong affinities to sub-area E_1, but with affinities to area B and some endemic species. This is, in fact, the situation that is now found. (See species list for sub-area E_2.)

Sub-area E_1 has a fauna dominated by a large number of species of *Maoridrilus*. The area extends across Cook Strait and includes a number of offshore islands in Cook Strait. Cotton and Te Punga (1955) state that solifluxion phenomena are found almost down to sea level in south-west Wellington and hold that forest could not have been present at the last glacial maximum (11,000 years ago) and probably for some time thereafter in the area covered by solifluxion deposits. In this respect Cotton and Te Punga take a rather more extreme view of the effects of glaciation than does Willett (1950). More detailed work on solifluxion near Wellington, by Stevens (1957), also indicates that periglacial conditions prevailed over much of the Wellington-Hutt Valley area. The earthworms that now inhabit sub-area E_1 are for the most part forest dwelling species, highly specialised in their ecological requirements and not found outside the margins of present forests. A large number of species are found in the vicinity of Cook Strait, and fewer species are found in the northern portion of area E. If there was no forest in south-west Wellington at the last glacial maximum, the exclusively forest-dwelling earthworms now found in that region must have entered it very recently and must have come from the north, where temperatures would have been higher and forest could have existed. The present earthworm distribution indicates that this is not so. It seems more likely that south-west Wellington has been the centre of evolutionary change for Neodrilacea and that many of the forest-dwelling species now found in areas C, F, and G have been derived from a forest-dwelling stock centred in or near south-west Wellington. It is therefore necessary to suppose that forests were present in south-west Wellington throughout glacial times, but they may have been confined to a coastal strip and need not necessarily

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have been as extensive as is indicated in Willett's map. Areas now forested that were formerly bare ground with solifluxion deposits must have been re-populated by earthworms very recently. Evidence of the recent origin of the fauna of the Tararua and Ruahine Ranges is found in the very widespread distribution of individual species. *Maoridrilus montanus* and *Deinodrilus montanus* are very common in these ranges and the latter species extends westwards to Mt. Egmont. *Octochaetus multiporus* and *Maoridrilus ruber* are also widespread on the mountain ranges. These four species now constitute almost the entire earthworm fauna of inland portions of sub-area E_1, whereas other portions of the sub-area (Cook Strait islands, Marlborough Sounds, coastal Wellington) have a large number of species (see species list under sub-area E_1). The situation in inland portions of sub-area E_1 (especially the mountain ranges) is analogous to that of area D, which has been affected by recent volcanic activity and populated by earthworms very recently. Both areas have a small number of species, each of which is widely distributed, and in both cases this situation is apparently due to the short time that has elapsed since earthworms were first able to inhabit the area, resulting in a lack of the geographical and ecological speciation characteristic of areas that have been continuously occupied by earthworms for a longer period of time.

There is no sharp boundary between area E and area G, but rather a gradual decline in the dominance of *Maoridrilus* spp. and an increase in the frequency of occurrence of species of genera that are not common or are unknown in area E. The south-east boundary of area E corresponds with a modern climatic boundary (Robertson, 1957) between an area (E) with 50–80 in. annual rainfall and an area (F) with 25–35 in. annual rainfall. The climatic boundary coincides with a vegetational boundary between forest (in area E) and induced tussock grassland (in area F).

Te Punga (1953) considered that the last remnant of a land connection between North and South Islands persisted until about 11,000 years ago between the regions of Waikanae and D'Urville Island. The presence of *Maoridrilus ruber* in the vicinity of Wellington, on Kapiti, Mana, and Stephen islands and the presence of *Deinodrilus gracilis* at Mt. Wainui (west coast of North Island, adjacent to Kapiti Island), on Kapiti Island, Stephen Island, and on the north coast of the South Island near Motueka, and the widespread distribution of *Octochaetus multiporus* in North and South Island portions of area E, may be taken as indications that a very recent continuous land area must have existed somewhere in the vicinity of Te Punga's proposed land connection. The presence of a considerable number of species endemic to Kapiti Island (*Octochaetus kapitiensis, Rhododrilus subtilis, Maoridrilus volutus, Neodrilus dissimilis*) might be interpreted as evidence for a long separation of the island from the mainland. However, with few exceptions, the endemic forest-dwelling earthworms of New Zealand are distributed over very small areas and it would be reasonable to expect to find a number of species confined within the boundaries of a forested region as large as Kapiti Island, even if it were not an isolated island but part of a larger, continuous forested area.

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The presence of *Neochaeta forsteri* in eastern Wairarapa and in Canterbury and its absence from sub-area E_1 indicates that there must at some time have been a connection between E_2 and F. Similar relationships in Opiliones led Forster (1954) to conclude that a land connection must have existed, independent of, but at about the same time as, the connecton from Waikanae to D'Urville Island postulated by Te Punga. Differences between eastern and western faunas in the North Island, correlated with similar differences in the South Island, could be accounted for by one land connection with a mountain barrier or periglacial conditions existing along its axis and maintaining a separation between eastern and western coastal strips of forest. Separation between the eastern and western faunal districts so defined would be continued northward and southward by the main dividing ranges of the North and South islands. It is therefore unnecessary to postulate the former existence of a land connection between eastern North and South Island districts, independent of the connection postulated by Te Punga.

South of area E, in areas F, G, H, and I, the effects of the Pleistocene glaciations were more severe. At its maximum extension, ice covered most of the Southern Alps, valley glaciers extended to the sea in the fiords of the south-west, and most of the west coast lowlands (central portion of area G) were covered by an extensive ice sheet. Willett (1950) considered that, east of the main divide (in area F), there would have been a wide band in which periglacial conditions prevailed and the land was barren and scree-covered, bordered on the east by dry, cold steppe, which would have extended to the present coastline except at Banks Peninsula, where a small remnant of *Nothofagus* forest may have persisted. Stewart Island, apart possibly from small remnants of forest close to the coast, was probably barren (Willett, 1950) and at glacial maxima was probably joined to the mainland (Fleming, 1949).

The wide extent of tussock grassland, which is at present the native vegetation type characteristic of most of area F, is of recent origin. Zotov (1938, p. 212A) stated that, "the tussock grasslands of New Zealand are of the general steppe type, conforming to this in all essential characteristics. Those portions which do not conform are of strictly induced formation." He mapped the approximate limits of tussock grassland as found by early European settlers and the limits of true steppes (i.e. those areas having a true steppe climate) and pointed out that the extension of steppe vegetation outside the true steppe limits has resulted principally from the effects of fire. The present limits of tussock grassland in the South Island correspond fairly closely with the boundaries of area F, while true steppe conditions are found only in two portions of area F, one a broad coastal strip of the Canterbury Plains and the other an inland area including the Central Otago and McKenzie basins and extending eastwards to within about 25 miles of the coast. (See Zotov's map, 1938, p. 215A). Holloway (1954) considered that destruction of the forests of eastern South Island followed a change toward a drier climate, which made the existing forest unstable. He considered that the climatic change

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took place about 700 years ago, and that the processes of adjustment of vegetation to the climate change are still going on.

The very recent nature of most of the tussock grasslands of area F may account for some unusual characters of the earthworm fauna of the area. Of a total of 25 species known from area F, only 4, *Eodrilus annectens, E. montanus, Maoridrilus alpinus,* and *Octochaetus antarcticus,* have been collected only from tussock grassland, while the remaining 21 species are confined to forests on the fringes of area F, or to small remnants of forest surrounded by tussock grassland within area F, or are found in tussock grasslands and in adjacent forests. The species most common in tussock grassland soils in area F are *Octochaetus multiporus, O. huttoni, Maoridrilus dissimilis,* and *M. uliginosus,* all of which are found also in forest soils. The earthworm fauna of tussock grassland soils in area F resembles that of the pumice soils of area D in that a very recent change in the soil environment, due to the nature of the parent material in area D and to a change in vegetation in area F, has produced conditions unfavourable to most but favourable to a few earthworm species, which have consequently achieved a wide distribution. The four species that have been found only in tussock grassland soils may be the only true tussock grassland earthworms in area F. Two of the species, *Eodrilus montanus* and *Maoridrilus alpinus,* have been collected only from Central Otago and the McKenzie Plains, within Zotov's boundaries of true steppe lands.

Maoridrilus ultimus, M. wilkini, M. modestus, M. purus, Neochaeta forsteri, Neodrilus campestris, Plagiochaeta sylvestris, Diporochaeta obtusa, and *D. punctata* are confined to forested areas on the fringes of area F or are sporadically distributed in forest remnants in area F. The sporadic occurrence of some species, especially *Maoridrilus modestus, M. purus, Neochaeta forsteri, Neodrilus campestris,* and *Plagiochaeta sylvestris* in scattered small forest areas is strong evidence for former continuity between areas of forest that are at present discontinuous.

The Pleistocene glacial period must have greatly affected the earthworm fauna of area F. Species that now inhabit forest soils on the eastern slopes of the main mountain divide of the South Island could not have been there at the glacial maximum, since it is unlikely that forests were present there at the glacial maximum (Willett, 1950). A few species (*Maoridrilus modestus, M. purus, Octochaetus multiporus*) probably persisted in forest remnants on Banks Peninsula, since their distribution in eastern South Island districts seems to be centred about Banks Peninsula, and some earthworms may have persisted in other small pockets of forest near the east coast. Other species (*Maoridrilus uliginosus, M. dissimilis, Neochaeta forsteri, Diporochaeta obtusa*) may have been confined to the north, at the southern end of area E, and spread southward into area F as the ice retreated, while others (*Octochaetus thomasi, O. huttoni, Plagiochaeta sylvestris,* and *Diporochaeta punctata*), which are more common in the southern end of area F than in the northern end, may have persisted in isolated remnants of forest near the coast in area H and spread northward as the ice retreated and the forest advanced. The very recent increase

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in the area of tussock grassland and decrease in forest area described by Zotov (1938) have resulted in fragmentation of the distribution patterns of species at present found in area F.

Although only three species are common to areas F and E, a strong resemblance exists between the faunas of the two areas. The sharp boundary that now exists between the two areas is due to a vegetational boundary induced by fire and would probably not be at all sharp had it not been for the destruction of the forests. The faunas of both areas are dominated by species of *Maoridrilus* and include closely related species, and it is likely that all these species were derived from a common ancestral stock, which was probably concentrated in the Cook Strait area during the last glacial maximum and has only achieved its present distribution during the last few thousand years.

In area G, conditions prevailing at the last glacial maximum must have greatly modified earthworm distribution. The northern and southern extremities of area G were apparently separated by an ice-covered coastal plain. The northern portion has a fauna very closely related to that of area E, but with some species (*Decachaetus minor, Sylvodrilus gravus*) more closely related to the fauna of areas to the south. These species may be survivors of a pre-glacial west coast fauna, isolated in small pockets of forest close to the coast during the glacial maximum. The southern portion of area G has a fauna closely related to that of area H and areas to the south of area H, but with little relationship to the faunas of areas to the north. The central portion of area G is populated by a few species from each of the northern and southern groups. All the species are inhabitants of forest soils, and must have followed the advance of forests back into the area covered by ice at the last glacial maximum.

There is no evidence of any considerable interchange of species between areas F and G. Since the last glacial maximum, the lower slopes of the main mountain divide have been re-populated by earthworms advancing along the flanks of the divide, apparently from the north and the south. The alpine climate of the high mountain tops has maintained a barrier between the faunas of areas F and G as re-population has proceeded.

Area H is characterised by the close similarity that exists between its fauna and the faunas of Snares, Auckland and Stewart Islands. There is also a close resemblance to a section of the faunas of other west coast districts of the North and South Islands, a resemblance that is also noticeable in the Auckland Islands fauna. It has been noted that this resemblance may be due to the presence of a relic of a former widespread western fauna. It would be of interest to have more information on the fauna of Resolution Island. This island was isolated by valley glaciers from the remainder of Fiordland during the Pleistocene glaciation and since the glaciers retreated has been an island. One species, *Perieodrilus ricardi,* is known from the island and from nowhere else. The only other representatives of the genus are in Fiordland and Snares Islands. It is likely that Resolution Island would provide a sample of other relics of a pre-glacial fauna, and a study of its earthworm fauna could throw much light on the relationships of

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South Island earthworms to those of the North Island and subantarctic islands.

Area I (Stewart Island) has a fauna closely related to those of areas F and H. As the island was probably joined to the south coast of the South Island at glacial maxima, and forest or scrub may have been present close to the coast throughout the glacial period, discontinuity between areas F, H, and I is comparatively recent and little difference exists between the fauna of Stewart Island and that of the southern portion of the South Island.

The earthworm fauna of Snares Islands is closely related to that of area H. The Snares Islands rise from a southward extension of the New Zealand coastal shelf and it is possible that they have been connected to the South Island or Stewart Island in comparatively recent geological times. Resemblances between the faunas of Snares Islands and area H are at the generic level, and the two areas have no species in common. At some time during the Tertiary there must have been a connection between area H and Snares Islands, and the fauna of Snares Islands must have survived the Pleistocene glaciations.

The subantarctic islands (Auckland, Campbell, Antipodes and Macquarie Islands) have earthworm faunas that, in the past, have been used as a basis for argument on the origin of the New Zealand fauna. The argument was based on the distribution of *Microscolex,* which occurs in all four island groups. The species of *Microscolex* were formerly included in *Notiodrilus,* which was taken by Michaelsen to be the "root genus" of the family Megascolecidae. It was argued that earthworms are unable to withstand immersion in salt water and, therefore, must have been able to move across continuous land bridges to achieve their present distribution. Further, it was argued that the New Zealand Acanthodrilinae were derived from forms similar to the species of *Notiodrilus* found in subantarctic islands. Since related species of *Notiodrilus* were known from South America and South Africa and there appeared to be a fairly close relationship between the acanthodriline faunas of all southern land areas, it was argued that acanthodriline earthworms may have originated in one or other of the southern land masses and migrated through the antarctic continent, at a time when that area had a warmer climate and a well developed vegetation, over land bridges to the present southern lands. The predominance of Acanthodrilinae, especially species of *Notiodrilus,* in subantarctic islands was offered as evidence for a migration route of which the present subantarctic islands are remnants. Examination of the earthworm fauna of New Zealand subantarctic islands gives little or no support to a southern origin for the fauna. The species present, apart from those of *Microscolex* (=*Notiodrilus*), belong to genera that are endemic in the New Zealand region (*Rhododrilus*) or have their closest affinities with New Zealand, north-eastern Australian and Indo-Malayan species (*Perionyx, Diporochaeta, Plutellus*). Some of the species are known to be euryhaline (*Rhododrilus cockaynei, R. leptomerus*) and their presence on oceanic islands presents no problems. The species of *Microscolex* known from New Zealand subantarctic islands are euryhaline and belong to a circum-polar group of species of *Microscolex*

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with representatives in other islands and land areas in and adjacent to the southern ocean. They are not closely related to any New Zealand species. The West Wind Drift could easily transport euryhaline species from island to island with rafted material.

Short range effects of the West Wind Drift may be seen in the distribution patterns of euryhaline species found in New Zealand subantarctic islands. Auckland Islands have a fauna consisting of ten species, with closest relationships to the faunas of area H and Snares Islands (see faunal lists). Campbell, Antipodes and Snares Islands are all east of Auckland Islands and consequently material drifting with the West Wind Drift from Auckland Islands could be stranded on any of these islands. Three euryhaline species, *Microscolex campbellianus, Rhododrilus cockaynei,* and *R. leptomerus,* which are known from Auckland Islands, appear to have been so distributed. All three are found on Campbell Island and are the only species of earthworms known there. *Microscolex campbellianus* is the only species known from Antipodes Islands. *Rhododrilus cockaynei* is found on Snares Islands and at the southern end of the South Island. The absence of endemic species peculiar to Campbell and Antipodes Islands and the small number of species indicate that the fauna is of recent origin and the constitution of the fauna indicates that it has probably been derived from the fauna of Auckland Islands. Further evidence of the very recent origin of the fauna is found in the distribution of earthworms on Campbell Island. Most of the specimens collected have come from the shore, under logs and stones, or in soils immediately adjacent to the shore. A few specimens of *Rhododrilus cockaynei* have been collected from localities other than the shoreline, in forest soils. Generally, megascolecid species have specialised environmental requirements and are found only in small areas within a restricted range of vegetation types. There are exceptions to this generalisation (e.g. *Diporochaeta obtusa* on the New Zealand mainland) but where such exceptional species are found other species of more restricted distribution are found with them. In Campbell Island, only widely distributed species are present. Campbell Island is a Pliocene volcano, glaciated down to about 500 ft. above sea level in the Pleistocene (Fleming, 1949). It is very likely that it has been re-populated by earthworms since the close of the Pleistocene glacial period. The situation is comparable to that of northern Europe and North America, where earthworms (Lumbricidae) have recently migrated northward into areas that were uninhabitable during the glacial maximum; today a few species are very widely distributed, and individual species do not display the high degree of ecological specialisation commonly found in the earthworm faunas of the warmer regions of the earth. The presence of a richer earthworm fauna on the Auckland Islands than on Campbell or Antipodes Islands may be due to the longer history and probable former greater extent of land in that area and the greater likelihood of coastal scrub or forest surviving and providing a habitat for earthworms through glacial maxima on the more northern Auckland Islands. Fleming (1949, p. 86) quoted unpublished work by Willett, who estimated that the snowline at the Auckland Islands was below

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1,000 ft. during the maximum extension of glacial ice in the Pleistocene. A coastal strip of vegetation, which would provide conditions suitable for the survival of earthworms, may therefore have been present throughout the glacial period.

Only three species of Megascolecidae are known from the Chatham Islands. Two of them are closely related to New Zealand species and are of small size; chance transport in drifting debris or carriage by birds may account for their presence. The third species is *Pontodrilus matsushimensis* var. *chathamianus,* a local variety of a euryhaline, shore-dwelling species common on Pacific islands, which must be excluded from any discussion of the relationships of the New Zealand earthworm fauna. The small number of species in the land-dwelling earthworm fauna of the islands is evidence that there has been no recent nor long lasting connection between the islands and the New Zealand mainland.

GEOGRAPHICAL SPECIATION

Geographical isolation and subsequent renewal of continuity between sections of the New Zealand fauna have been features of the Tertiary and Recent periods. No reliable information is available on the rate of evolution of Megascolecidae. Only negative evidence is available from the New Zealand fauna. It is known from radiocarbon dating (Ferguson and Rafter, in Baumgart, 1954) that the most recent Taupo ash shower is about 1,700 years old, and there is no species of earthworm which can with any certainty be said to be peculiar to the area covered by the shower. Te Punga (1953) considers that a land connection existed between the North Island and the South Island until about 11,000 years ago, probably including Kapiti and Stephen Islands. There are considerable differences between the faunal lists for northern South Island and southern North Island districts, but there are very close similarities; *Maoridrilus ruber, Octochaetus multiporus, Deinodrilus gracilis,* and *Diporochaeta obtusa* are discontinuously distributed along the line of Te Punga's land connection, in areas now isolated. Some speciation may have occurred in the period during which geographical isolation has been effective, but at least for the four species listed, 11,000 years of geographical separation has been insufficient for the development of any difference which would justify recognition of infra-specific forms. The very wide distribution of a few species typical of forest lands in the tussock grassland soils of eastern South Island, and the small number of species peculiar to tussock grassland soils in this area, indicates a lack of sufficient time for the differentiation of such forms. Much of the present wide extent of tussock vegetation is due to destruction of forests by fire (see discussion of area F, p. 406) in very recent times and it would not be expected that species peculiar to much of the area of tussock grassland soils would have had time to develop. Moreover, the distribution of earthworms in the whole of the eastern portion of the South Island is characterised by the very wide distribution of

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individual species and the absence of species showing a high degree of ecological specialisation. Most of this portion of the South Island must have been re-populated by earthworms since the close of the most recent glaciation and there has apparently been insufficient time for the establishment of new species peculiar to the present vegetation types.

The very wide distribution beyond the New Zealand region of some megascolecid genera (e.g. *Eodrilus, Octochaetus, Microscolex*) indicates that the family Megascolecidae is a very ancient and slowly evolving group, comparable perhaps to the Brachiopoda, representatives of which have survived relatively unchanged through long periods of geological time. The first Acanthodrilinae may have entered New Zealand during the upper Cretaceous when much of the older element of New Zealand's fauna may have entered the region over a land connection from the north (Fleming, 1957). Once established in New Zealand, the Acanthodrilinae and, at a later time, the Megascolecinae, probably continued to evolve very slowly.

The archipelagic nature of the New Zealand region and the changes that have occurred during Tertiary times in the distribution of land and sea, mountain building and the deposition of volcanic material have provided the conditions of long continued geographical isolation responsible for the establishment and maintenance of the boundaries separating the principal faunal areas. Speciation within these boundaries, however, seems to have been rather a result of isolation due to the establishment of narrowly limited habitat preferences than to geographical isolation.

ORIGIN AND RELATIONSHIPS OF NEW ZEALAND MEGASCOLECIDAE

The origin and relationships of New Zealand earthworms have provided the basis for much argument. Beddard (1895a, c) discussed the similarity between the acanthodriline faunas of New Zealand, Patagonia and South Africa, and concluded that land connections must formerly have existed between these isolated land areas, to explain the close relationships which appeared to exist. Michaelsen (1896) opposed this interpretation of the distribution and considered that Acanthodrilinae and the remainder of the subfamily Megascolecinae may have originated in northern land masses and radiated southwards to attain their present distribution. Glossoscolecidae and Lumbricidae, which now dominate the earthworm faunas of northern land areas, in Michaelsen's opinion replaced Megascolecidae in the north, and the latter have become restricted to the southern extremities of the southern land masses. Benham (1902, 1909, 1922) argued in favour of Beddard's hypothesis while Michaelsen (1903a, b, 1904, 1905, 1907a, 1909, 1911) and Stephenson (1921b, 1923, 1930) argued for the other hypothesis. The parties to this argument did not come to any agreement, possibly because the New Zealand Megascolecidae, as known to them, included very few North Island species.

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From the information contained in this work, the following conclusions on probable relationships, origins and paths of migration can reasonably be drawn.

1. New Zealand Acanthodrilinae are related to those of South America, South Africa, Australia and subantarctic islands. The relationship, however, is not as close as has been supposed. *Microscolex* may be omitted from this discussion since no species of this genus is endemic on the New Zealand mainland and the few species that are endemic on subantarctic islands belong to a circum-polar group of euryhaline species which has probably been distributed recently by the West Wind Drift. *Acanthodrilus* may similarly be omitted, since it has been found only on Raoul Island in the New Zealand region and is otherwise known only from New Caledonia. *Eodrilus* and *Octochaetus* are the only other genera that are common to New Zealand and other countries. Of these, *Eodrilus* is distributed in southern land areas but also occurs in Central America, northern Australia, and western Africa, while *Octochaetus* is found only in India and New Zealand. The evidence of acanthodriline distribution may therefore be interpreted as indicating a southern or a northern origin for the group, depending upon which section of the evidence is selected as significant.

2. New Zealand Megascolecinae are closely related to those of Australia and Indo-Malaya. All the genera found in New Zealand are found also in Australia. Megascolecinae are common in the north and west of New Zealand and rare in the east, while Acanthodrilinae are found in all districts. All the New Zealand representatives (29 species) of four megascolecine genera are confined to the north of the North Island (mostly to area A). The evidence of megascolecine distribution within the New Zealand region may therefore be taken to indicate a northern origin for the Megascolecinae. It seems likely that there has been, at some remote time in the past, a land area to the west of the present New Zealand mainland, from which Megascolecinae have also been able to enter western districts of New Zealand. The present distribution of Megascolecinae, with a concentration in the north of New Zealand, illustrates Michaelsen's hypothesis of southward migration of Megascolecidae. The northern New Zealand species (in particular, the 29 species of the genera *Megascolex, Megascolides, Notoscolex* and *Spenceriella*) have apparently come from the north and are moving southward, but have been prevented by unfavourable conditions, particularly the pumice soils of area D, from reaching the southern end of the New Zealand mainland.

3. The absence of Megascolecinae in some New Zealand districts and the general absence of indigenous megascolecine genera contrast with the presence of Acanthodrilinae in all New Zealand districts, and the fact that all but a few of the New Zealand acanthodriline genera are confined to New Zealand. This indicates that Acanthodrilinae are much older in the New Zealand region than Megascolecinae.

Fleming (1949, 1957) has summarised the geological history of New Zealand and attempted to relate knowledge of the past and present

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fauna to geological findings. Referring to "land bridges", Fleming (1957) considers that a nucleus of terrestrial and littoral plants and animals may have reached New Zealand during Cretaceous times over a land bridge, either from the north or the south. Acanthodrilinae may have entered New Zealand at this time. A long period of isolation from northern land masses has ensued, but (according to Fleming (1957)) Tertiary connections to the north may have facilitated the southward spread of Melanesian organisms that came too late to use the Cretaceous bridge. Such Tertiary connections may have provided a path for the entry of the northern group of New Zealand Megascolecinae. It is not necessary to suppose that a continuous land bridge of any great extent existed at any one time. If there had been an extensive archipelago, earthworms may have moved across land connections or been transported between neighbouring islands, and eventually reached New Zealand.

Continental drift has occasionally been invoked to explain the constitution of the New Zealand fauna. Michaelsen (1922a) interpreted the distribution of Oligochaeta in terms of Wegener's theory. A map of the supposed configuration of land in the Carboniferous (loc. cit., p. 28) shows an interpretation of the distribution of a number of genera. Most of the modern megascolecid genera would need to have survived, relatively unchanged, since the Carboniferous to satisfy this theory. It has already been pointed out that Megascolecidae seem to be an ancient and slowly evolving group of animals, but it seems unlikely that most of the genera have remained unchanged throughout so long a period of geological time.

Continental drift as a primary cause of the relationships of New Zealand animals has received little attention in recent years. However, Paramonov (1955), discussing the New Zealand Diptera, dismissed the idea of land bridges as untenable as an explanation of the distribution of some families, and stated that, "if we accept Wegener's theory of the drifting continents, we can accept the drift of New Zealand to the polar area, which destroyed the more warmth-liking elements [of the Diptera] and then back-drift to the warmer areas. As a result of the very marked isolation by the vast surface of ocean there was no possibility of receiving again the warmth-liking elements. .... New Zealand has received its cold-liking elements from the antarctic area." It seems to the present author more likely that a land connection, for which there is considerable geological evidence, existed than that New Zealand as a whole moved over some thousands of miles of the earth's surface to the polar area and then, for no specified reason, reversed its direction of movement and returned to temperate regions.

Taking all the available evidence into account, it seems most likely that the New Zealand Megascolecidae entered the New Zealand region over a land bridge from the north. They probably arrived in at least two waves, the first (subfamily Acanthodrilinae) in Cretaceous times and the second (subfamily Megascolecinae) in Tertiary times. Evidence for a northern origin for Megascolecinae is very strong, but for Acanthodrilinae is not so strong. It is possible that the Acanthodrilinae

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came from the south, but acceptance of a southern origin for this section of the fauna requires the postulation of a number of other hypotheses. These include the presence of very extensive land bridges where there is now deep sea and a contemporaneous temperate climate in the antarctic continent. The postulation of other, northern, land connections is still required to account for the origin of New Zealand Megascolecinae. Continental drift cannot satisfactorily explain the present distribution of Megascolecidae, since it requires that the constitution of New Zealand's fauna should have been fixed at one time, probably in the Paleozoic, and have remained almost constant since then.

Evidence from other groups of animals indicates a northern origin for the more recent portion of the fauna of New Zealand. Forster (1954) found that New Zealand Opiliones are closely related at a generic level to Australian and New Caledonian forms. Fleming (1949), summarising evidence from a number of groups of animals and plants, concluded that a northern origin was most likely for Tertiary migrants. The present distribution of Megascolecinae strongly supports a northern origin for the more recent elements of the fauna, and there is little evidence for a southern origin even for the older Acanthodrilinae.

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Part Four

ECOLOGY

The earliest New Zealand work on earthworm ecology was reported by Urquhart (1884, 1887) and Smith (1887, 1893, 1894). This work followed closely after Darwin's work on the ecology of European worms (1881).

Urquhart studied earthworms in Auckland for several years from 1882 onwards. It is not clear what species were concerned, but they were probably lumbricids. He estimated the earthworm population in pasture soils as about 784,080 per acre (18 per sq. ft.). Darwin's (1881) estimate for English pastures was 26,886 per acre. On a grassed area at Manakau, Urquhart placed stones on the ground and in one case noted that after eight years a stone 6½ in. × 3½ in. × 3⅜ in. was embedded to a depth of an inch by the castings of earthworms and by its weight breaking in the tunnels of earthworms underneath it.

Smith studied earthworms in Canterbury for many years and for some time in the region of Lake Brunner. Most of his observations were on Megascolecidae, which he sent to Beddard for identification. He was the first to note (1894, p. 155) the disappearance of indigenous species when land was cleared of its native vegetation and their replacement by exotic (lumbricid) species. He considered (1893) that British and other exotic worms had been introduced into New Zealand at various times in the soil of plant cases and in soil used as ballast in ships. The rich land in many parts of the country, the genial climate, absence of their natural enemies, the distribution of English trees and shrubs from nurseries and their extensive planting throughout the country were reasons cited by Smith to account for the rapid dispersal and phenomenal increase in numbers of lumbricid earthworms. Smith (1893) listed seven lumbricids, one megascolecid, and one tubificid known to have been introduced into New Zealand.

Concerning indigenous Megascolecidae Smith (1887) noted that they were abundant in Canterbury soils where tussock growth was vigorous. On some parts of the plains there were few, and Smith attributed this to the wind (which, Darwin had found, earthworms do not like), but he noted that in places where water sometimes lies worms were more numerous. Megascolecidae were found sparingly up to 4,000 ft. on Mt. Peel, mainly under rotten logs, slabs, and stones. Smith attributed the mixing of fine sand and leaf mould on the flood plains of Canterbury rivers to the activities of earthworms. He observed that New Zealand earthworms make semi-circular and distinctly branching burrows and contrasted this with European worms which, according to Darwin, make burrows that run down perpendicularly or,

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more commonly, a little obliquely. In gardens, Smith found populations of about 300,000 per acre, in pastures 200,000 to 700,000 per acre (these were lumbricids), and in one place in tussock land a population of *Maoridrilus uliginosus* numbering about 400,000 per acre.

The work of Urquhart and Smith was stimulated by the publication of Darwin's work and was greatly influenced by Darwin's methods and ideas. Apart from occasional ecological notes appended to systematic descriptions by Benham, no further ecological work on New Zealand earthworms was published until the last few years when Sears and Evans, Waters, and Nielson published papers on the ecology of Lumbricidae in New Zealand pastures.

ENVIRONMENTAL REQUIREMENTS OF EARTHWORMS

For earthworms to survive, a number of environmental conditions must be fulfilled. The essential conditions appear to be as follows:

Adequate and suitable food supplies. Earthworms feed on dead and decaying plant remains, or occasionally animal remains. Because of their limited capacity for moving about, they are obliged to live very close to their sources of food.

Adequate moisture. Given adequate and suitable food supplies, the presence of free water in their immediate environment is the most essential requirement of earthworms. The success of any animal in a terrestrial environment depends largely upon its ability to conserve water. Water conservation mechanisms are virtually absent in earthworms. Respiration takes place by diffusion of gases through the body wall, which is heavily vascularised and has a thin cuticle. The outer surface of the body must remain moist so that transfer of gases may take place. Desiccation inhibits respiration and at the same time causes rapid water loss through the thin cuticle. Water is also lost through the nephridia with excretory products and must be replaced.

Adequate dissolved oxygen. There must be sufficient dissolved oxygen in the earthworm's environmental medium to meet the earthworm's requirements. Free water surfaces in contact with the air must be sufficient to maintain the oxygen supply at a level sufficient for respiratory exchange.

Protection from light. Earthworms are injured and may be killed by exposure to daylight except when the intensity is very low. Stephenson (1930, pp. 302–3) quotes papers by Zielinska and Merker on the sensitivity of various worms to daylight. These workers found that short wave lengths, particularly in the ultra-violet range, are most damaging. Zielinska found that pigmented species and deeply pigmented individuals of a species are more resistant to damage by light than the less pigmented.

Suitable temperatures. It has been shown by Smith, Welch, Terao and Hiruma, Hatai (all quoted by Stephenson (1930)) that earthworms of various species are killed by exposure to temperatures varying between 30° and 40° c. Temperatures of this order are attained in some New Zealand soils under low or sparse vegetation at depths of up to

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about an inch, during the summer. In most soils earthworms are able to retreat deeper into the soil to escape high temperatures, but in some soils and in habitats other than soils high temperatures can be important in limiting earthworm activities. Earthworms are usually able to escape freezing in habitats that are seasonally cold by retreating to deeper, unfrozen layers. They are unable to live in permanently frozen ground. Stephenson (1930, p. 620) quotes experiments by Korschelt and by Schmidt and Stchepkina, which showed that common European lumbricid species are unable to survive prolonged exposure to temperatures below 0° c.

Suitable pH conditions. The pH tolerance of earthworms varies from species to species. No New Zealand earthworms have been found in peats of pH lower than about 4·0, but since most soils are in the slightly acid to neutral range, soil-dwelling earthworms are not usually subjected to very high or very low pH, so that pH conditions have little influence on them.

Absence of toxic substances. Earthworms are excluded from habitats containing toxic substances. Examples may be found in soils with very high salinity, e.g. small salt patches in dry areas of inland Otago.

HABITATS OF NEW ZEALAND EARTHWORMS

Earthworms, despite the limitations imposed upon them by their environmental requirements, successfully occupy a wide range of habitats. The habitats from which New Zealand earthworms have been collected may be classified as follows:

Terrestrial
- soil, including leaf mould
- under logs and stones
- under the bark of dead trees; in rotting logs
- in decaying plant remains in the axils of branches of forest trees.

Aquatic
- in the mud and under stones of stream, pond and lake bottoms
- in the water of deep lakes
- in swamps
- in the intertidal zone on sea shores and in brackish water adjacent to the sea.

TERRESTRIAL HABITATS

SOIL

Earthworms, as their name implies, have achieved their greatest success as soil dwelling animals. The New Zealand fauna has been isolated geographically for a long period of geological time. A number of major animal groups (e.g. mammals, amphibians) are represented by only a few species or are entirely absent. The groups represented have, in some cases, given rise to a wide range of species, morphologically and physiologically specialised to fit them each for a very limited range of ecological conditions. New Zealand Megascolecidae are such a group, and their morphological variety is most obvious in the soil-inhabiting species.

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For all soil-dwelling species, the primary source of food is the plant litter or leaf mould, which makes up the superficial soil layer and is renewed from the plant cover. Generally, under forest, scrub, or tussock grassland vegetation, where most New Zealand Megascolecidae are found, a plentiful supply of plant debris is available and food shortage can rarely be of any importance in limiting earthworm populations.

An obvious stratification of earthworms into a leaf mould group, a topsoil group, and a subsoil group is found in most New Zealand forest soils.

Leaf mould earthworms are small, very active, heavily pigmented species. The smallest known New Zealand species is 15 mm. long and the largest 180 mm., but most species are between 20 mm. and 50 mm. long. They are frequently very thick in proportion to their length, owing to the great thickness of muscle layers in the body wall. In ten species taken at random and ranging from 20 mm. to 54 mm. in length, the length is from eight to seventeen times the diameter. They do not make permanent burrows, but move about in the leaf mould. Because of this they are more liable to capture by predatory birds and would be more frequently exposed to light than topsoil or subsoil species. Their ability to move quickly gives them some protection, and their heavy pigmentation, often with strongly contrasting combinations of colours, would give some protection from the harmful effects of ultra-violet light and provide a degree of camouflage in leaf mould, where particles of plant debris of varying size, shape, and colour are exposed to varying light intensities. Thirty-six species of New Zealand Megascolecidae are found almost exclusively in leaf mould and a number of others are found sometimes in leaf mould. Most leaf mould species are distributed over small areas, although a few (*Diporochaeta obtusa, Diporochaeta punctata, Neochaeta forsteri, Plagiochaeta sylvestris*) are widely distributed.

Topsoil earthworms are generally larger than leaf mould earthworms. The smallest New Zealand topsoil species is about 25 mm. long, and the largest is 300 mm., but most species are between 75 mm. and 200 mm. They are usually pigmented, red or brown, but not as heavily pigmented as leaf mould species. They are able to move quickly, but are not as active as leaf mould species. In most species the body is circular in cross section and the muscle layers are not thick, but in some species (especially *Maoridrilus* spp., *Neodrilus* spp.) the body is almost square in cross section with the pairs of chaetae on the four corners, and the body wall has thick muscle layers. Such species are generally more active than those with a circular cross section. In ten species taken at random and ranging from 25 mm. to 225 mm. in length, the length is from fifteen to forty times the diameter. Topsoil earthworms make permanent burrows, leaving them only to forage for food in the leaf mould. They are less likely to be attacked by predators than are the leaf mould species and they have fewer competitors for the food in their own habitat. Forty-eight species of New Zealand Megascolecidae are found almost exclusively in topsoil and a number of other species are occasionally found in topsoil. A number of topsoil species found

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in tussock grassland areas (species of *Rhododrilus* in area D (Fig. 368) and of *Maoridrilus* in area F) are very widely distributed, but most other topsoil species are confined to small areas.

Subsoil earthworms are usually very large, sluggish, and unpigmented or only lightly pigmented. The smallest New Zealand species is 32·5 mm. in length and the largest 1,300–1,400 mm., but most species are between 100 mm. and 400 mm. in length. Most species are circular in cross section and the muscles of the body wall are very weakly developed, e.g. in *Octochaetus multiporus,* in which the body wall is almost transparent and the musculature is so weakly developed that ejection of coelomic fluid through the dorsal pores (the worm ejects coelomic fluid when irritated) causes collapse of the body wall. In ten species taken at random and ranging from 88 mm. to 1400 mm. in length, the length is from 20 to 130 times the diameter. Subsoil earthworms make very extensive burrows, which, in the case of *Spenceriella gigantea,* are up to about 20 mm. in diameter. They occasionally come to the surface or close to the surface for food, but otherwise are found only in the subsoil. Several subsoil species are very widely distributed, e.g. *Octochaetus multiporus* is found throughout the southern half of the North Island, the South Island east of the main dividing range and Stewart Island; most subsoil species are more widely distributed than are most leaf mould and topsoil species.

Since earthworms are dependent on favourable moisture conditions, they are susceptible to seasonal and short term changes in the moisture content of soils. In forest soils I have rarely found any evidence of severe desiccation, but under other types of vegetation desiccation is of some importance.

Near Bealey, under beech (*Nothofagus cliffortioides*) forest growing on Tekoa silt loam (soil type from Gibbs and Beggs, 1953) desiccation is more severe on steep slopes than on moderate slopes. Specimens of *Maoridrilus modestus* were found at depths of 3 in. to 6 in. on slopes of 5° to 10°, but on slopes of 25° or more no worms could be found. Similar small scale variations in the distribution of earthworms are found, at least during dry weather, in forested hill country throughout New Zealand.

Where the vegetation is other than forest the effects of desiccation are more noticeable. The distribution of *Rhododrilus similis, R. robustus,* and *R. albidus* in yellow brown pumice soils in the North Island (area D) is related to soil moisture. On steep slopes, where drainage is rapid through coarse pumice and between tussocks or other plants where vegetation is sparse, earthworms are absent or are rarely found, while on gentle slopes or flats and frequently under individual tussock plants in areas with sparse vegetation, the three species are commonly found. Near Alexandra, on Old Man Range, *Octochaetus multiporus* is common in the subsoil at depths of 6 in. to 12 in. under tussock (*Festuca novae-zelandiae*) on slopes with an easterly to south-easterly aspect, while on slopes with northerly to north-westerly aspect, where soils become very dry during the hot dry summers and the vegetation is sparse, *Octochaetus multiporus* is usually absent, and smaller topsoil species (*Maoridrilus dissimilis, Allolobophora caliginosa, Eodrilus paludosus*) are found living in the upper 2 in. to 6 in. directly under tussock or scabweed (*Raoulia* sp.). The same situation is found in many places where *Octochaetus multiporus* lives in soils that dry out severely in the summer (e.g. Canterbury, Wairarapa).

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The lumbricid species that inhabit pasture soils and live very close to the surface (commonly *Allolobophora caliginosa, A. terrestris* forma *longa, Lumbricus rubellus*) are able to avoid desiccation in the topsoil by retreating to the subsoil where they aestivate until the return of more favourable moisture conditions in the topsoil. During the summer, throughout most New Zealand districts east of the main dividing ranges, lumbricid worms are found aestivating at depths up to about three feet in the subsoil. Unusual circumstances may occasionally prohibit aestivation and other means of assuring the continuance of a population may be adopted. At Ahuriri, Napier, where a shallow lagoon bottom was raised above sea level by an earth movement in 1931, some areas close to present sea level have strongly saline ground waters although they support some rye, fescue, and white clover. In such an area, about one foot above high tide level, adult specimens of *Allolobophora terrestris* forma *longa* were found in July, when the topsoil was moist from winter rains, but in December when the topsoil was very dry, no worms could be found, but a cocoon of *A. terrestris* was found at a depth of about four inches. The water table, which is governed by the tides, is not affected by the seasons. In the hot dry summers characteristic of the Napier district, worms cannot live in the topsoil because of moisture shortage, and since the only species present is unable to live in salt water it is prevented from aestivating deeper in the soil and must die. Adult worms may survive in nearby, slightly higher ground, but where the ground is lower only cocoons are able to survive the summer drought.

Heavy rain, sufficient to flood burrows, forces earthworms to the surface, where they may die from exposure to sunlight. The worms are probably driven out by exhaustion of the dissolved oxygen in the water in their burrows. Rapid replacement of the oxygen as it is used is not possible in the circumstances since, in narrow burrows, only a small surface area of water relative to the volume is exposed to the air.

UNDER LOGS AND STONES

This habitat is very like the soil and might be included with the soil, but it has some unique features and is consequently separated. The cover provided by the log or stone provides protection from light, insulates the animal to some extent from variations in atmospheric humidity, and protects it from most predators. There is no need for a burrow of the normal type, a small excavation or natural irregularity in the stone or log being sufficient. Twenty-three species of New Zealand Megascolecidae have been collected from under logs and stones. Most of these have also been collected from the soil. The advantages for an earthworm of living under a stone or log are considerable, and where they are available they appear to be favoured by soil-dwelling species.

The presence of logs or stones sometimes facilitates the existence of earthworms where otherwise they might be excluded because of some unfavourable environmental condition. Mr J. S. Edwards (pers. comm.) has described such a situation at Little Barrier Island. Earthworms were collected under boulders very close to the sea on the shoreward side of a storm bank. He collected them along a transect from boulder-strewn ground covered by *Muehlenbeckia complexa* close to the crest of the storm bank, through a short transitional zone to pasture. (See Fig. 369). Earthworms were found under some boulders at A. They

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increased to a maximum at B, where there was a maximum of partly buried boulders, and decreased in the pasture as the number of boulders on the ground surface decreased. Edwards turned over several thousand stones and found earthworms under stones almost to the extreme seaward limit of the vegetation (within five yards of the limit of the storm debris zone). The species present were *Allolobophora caliginosa* and *Octolasium cyaneum*, neither of which is capable of surviving exposure to salt water. Edwards found that the worms almost invariably were close to the landward edge of the boulders, and not close to the seaward edge. In this position they would be least likely to be exposed to the sea water, which must fall in large quantities on the stones when spray is thrown up during storms. If the shelter provided by the boulders were absent it is unlikely that earthworms would be able to live so close to the sea.

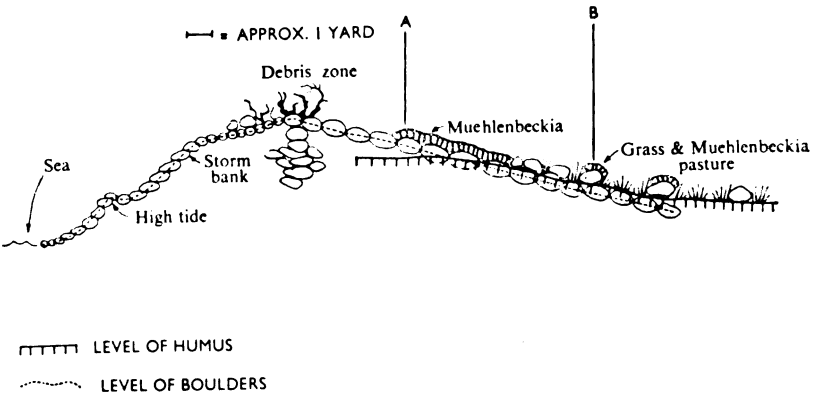

FIG. 369. Distribution of earthworms on and adjacent to storm bank, shore of Little Barrier Island. (From a sketch by J. S. Edwards)

Ten species of earthworms are known from Auckland Islands, and all have been recorded under logs and stones. Most of the area of Auckland Islands is covered by a deep layer of acid peat (pH range 3·6 to 4·6). Some, if not all, of the species of Auckland Islands earthworms are euryhaline and live on the shore. Such species probably find optimum conditions at near neutral or slightly alkaline pH, since the pH of sea water is about 8, and would therefore find the acid conditions prevailing in the peat soils unsuitable. By living under logs and stones on the surface of the peat they would be to some extent removed from the acid soil conditions.

UNDER THE BARK OF DEAD TREES; IN ROTTING LOGS

In most respects these habitats closely resemble the under-log and under-stone habitat. There is little to distinguish the conditions under bark from those in rotting logs, except that in the former case earthworms may live high above the ground in standing dead trees. Mr G. B. Rawlings, N.Z. Forest Service, (pers. comm.) has recorded an earthworm of a species that usually lives in the topsoil, under the bark of a dead pine about 100 ft. above the ground. *Lumbricus rubellus* may frequently be found under the bark of dead trees. *Perieodrilus montanus* is the only New Zealand megascolecid species to be recorded from under bark.

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Dinodriloides beddardi, Maoridrilus ruber, Megascolides maoricus, and *Megascolides suteri* have been collected in rotting logs. Of these, the first three occur in leaf mould, topsoil, subsoil, under logs, under stones, as well as in rotting logs; the last is found almost exclusively in rotting logs and only rarely in leaf mould or topsoil. The first three species probably use the logs only as shelter and forage for food nearby, but examination of the gut contents of *Megascolides suteri* reveals that it ingests and appears to digest decaying fragments of wood. Anteriorly the gut is filled with wood fragments, which become progressively more diffuse in outline until at the posterior end of the intestine only lace-like, fibrous fragments can be found.

AXILS OF BRANCHES OF FOREST TREES

Where epiphytes (e.g. *Astelia* spp.) grow in the axils of forest trees, a habitat closely similar to the leaf mould stratum of the soil is found. In this habitat earthworms similar to or identical with those of the leaf mould are found.

AQUATIC HABITATS

Earthworms differ only very slightly from aquatic animals. Consequently, most, if not all, species are able to live in water, although there are only a few species that show a preference for aquatic habitats. These species should not be confused with a number of families of small Oligochaeta (Aeolosomatidae, Naididae, Tubificidae, Phreodrilidae, Enchytraeidae, Lumbriculidae, Branchiobdellidae, Haplotaxidae, Alluroididae, collectively known as "microdrili") whose species are for the most part wholly aquatic. The aquatic "earthworms" have apparently been derived from terrestrial ancestors and have secondarily adopted aquatic habitats, whereas the "microdrili" are primarily aquatic animals.

IN MUD AND UNDER STONES OF STREAM, POND, AND LAKE BOTTOMS

Eiseniella tetraedra, an introduced lumbricid, is characteristically found in New Zealand under boulders in fast-flowing streams and occasionally in the water of swamps. It is found in similar habitats in Europe.

Allolobophora chlorotica is found in streams and lakes in England (Cernosvitov, 1945; Roots 1955). This species has been recorded from soil in New Zealand, but not from lakes or streams.

Of the endemic Megascolecidae only *Rhododrilus aquaticus* has been found living under stones in fresh water, at Caswell Sound. The same species has also been found in brackish water and, as far as is known, is an entirely aquatic species. *R. aquaticus* is not obviously specialised for an aquatic life.

IN WATER OF DEEP LAKES

Two megascolecid species, *Diporochaeta aquatica* and *Pontodrilus lacustris,* have been collected from deep water, the former in Lake Manapouri and the latter in Lake Wakatipu. They apparently swim freely in the lake waters and must feed on organic matter suspended in or sinking through the water. The apparent absence of similar aquatic worms from other New Zealand lakes may be due only to lack of suitable sampling. The resemblance of *P. lacustris* to New Zealand

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species of *Plutellus* has been discussed in the systematic section of this work.

IN SWAMPS

A few earthworms are found living an aquatic or semi-aquatic life in swamps. Four species of New Zealand Megascolecidae, *Decachaetus violaceus, Diporochaeta chathamensis, Eodrilus paludosus,* and *Perionyx helophilus,* have been collected from swamps and bogs. The first two have each been recorded only once, while the remaining two have been collected from various habitats, including swamps. It cannot therefore be said that there are any New Zealand Megascolecidae that are undoubtedly confined to swamps.

The anaerobic conditions typical of the sub-surface horizons in swamps would prevent earthworms from living anywhere but in surface water or very close to the surface. *Pelodrilus bipapillatus* (Fam. Haplotaxidae) is a common oligochaete in New Zealand swamps. This species is very slender in proportion to its length, a feature that fits it for life in an environment with low oxygen tensions, since its surface/volume ratio is higher than that of a shorter, thicker species. Since respiration takes place by diffusion of gases in solution through the integument, worms with a high surface/volume ratio have an advantage over those with a low surface/volume ratio if there is a shortage of oxygen.

INTERTIDAL ZONE AND IN BRACKISH WATER

Much work on the distribution and manner of dispersal of earthworms has been based on the assumption that they are unable to survive immersion, even for a short period, in salt water, and consequently cannot have been transported across the sea by rafting. That some of the common European Lumbricidae are unable to live in salt water is true, but a number of Megascolecidae live in the intertidal zone of seashores under stones and debris, or in brackish water. New Zealand species known from such habitats are *Microscolex aucklandicus, M. campbellianus, M. macquariensis, Pontodrilus matsushimensis* var. *chathamianus, Rhododrilus aquaticus, R. cockaynei,* and *R. leptomerus.* Of these species *M. aucklandicus, M. campbellianus, M. macquariensis, R. cockaynei,* and *R. leptomerus* are found under stones, logs, and in soil under tussocks, forest or other vegetation as well as in the intertidal zone. They are therefore well fitted for the colonisation of the isolated subantarctic islands on which they are found as the dominant section of the earthworm fauna. *Pontodrilus matsushimensis* var. *chathamianus* is a Chatham Island seashore worm, a local variant of a species widely distributed on the shores of Pacific islands.

EARTHWORM ECOLOGY IN RELATION TO NEW ZEALAND SOILS

Since soil is the natural habitat of most earthworms, no account of their ecology could be complete which did not discuss the relationships between earthworms and the classification and distribution of the soils in which they live.

In discussing earthworm ecology in relation to New Zealand soils, the groups of soils referred to are those in the classification below. This classification has been prepared by N. H. Taylor and is based on a classification prepared for the soil maps in "A Descriptive Atlas of New

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Zealand" (McLintock, in press), slightly modified to suit the requirements of this work. It is closely similar to the classification of Taylor (1948). Further information on New Zealand soils and on the total areas occupied by the various soil groups listed in the classification has been derived from Taylor and Cox (1956). Earthworm ecology is considered first in relation to the characters and distribution of the soil groups and then each of the soil forming factors, viz., parent material, topography, climate, time, and a biological factor, which includes the effects of the vegetation and soil inhabiting organisms on soil formation, is taken separately and its relationship to earthworm ecology and distribution is considered.

CLASSIFICATION OF NEW ZEALAND SOILS

Zonal Soils

Zone	*Soil Group*
Cold to cool, semi-arid	Brown-grey earths
Cool to mild, subhumid	Yellow-grey earths Soils related to yellow-grey earths, with gravelly or stony subsoils
Cold, humid	Yellow-brown earths, weakly weathered
Cool to mild, humid and superhumid	Yellow-brown earths, moderately weathered Podzolized yellow-brown earths and podzols, moderately weathered Gley podzols
Warm, humid	Yellow-brown earths, strongly weathered Podzolised yellow-brown earths and podzols, strongly weathered

Intrazonal and Azonal Soils

Non-zonal Impress	*Soil Group*
Young soils from dune sands	Yellow-brown sands
Young soils from rhyolitic pumice	Yellow-brown pumice soils
Friable soils from volcanic ash, with clays high in alumina	Yellow-brown loams
Red and brown soils from basic volcanic rocks, with clays high in iron oxides and alumina	Red-brown loams and brown granular clays
Peaty soils with high groundwater	Organic soils
Mineral soils with high groundwater	Gley soils
Mineral soils with high saline groundwater	Saline gley soils
Accumulating and recently accumulated soils — On river flats	Recent soils from alluvium
Accumulating and recently accumulated soils — Adjacent to volcanoes	Recent soils from volcanic ash
Rejuvenating soils on steep slopes	Skeletal brown-earths " yellow-grey earths " yellow-brown earths etc.

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ECOLOGY AND DISTRIBUTION IN RELATION TO SOIL GROUPINGS

ZONAL SOILS

Zonal soils are those whose main characteristics are due to the impress of climate and vegetation. They are distinguished from intrazonal and azonal soils, whose main characters are due to the impress of factors other than climate and vegetation, e.g. youth, unusual parent material such as volcanic ash, very steep topography, high water table.

Brown-grey Earths

Brown-grey earths occupy about 2 million acres, mainly in dry intermontane basins of Central Otago and the McKenzie Plains (Taylor and Cox, 1956). Associated with these soils are about ½ million acres of skeletal brown-grey earths. They are characterised by their low rainfall (12 in. to 20 in. per annum); for the greater part of the year rainfall is inadequate for optimum plant growth.

The distribution and ecology of earthworms in brown-grey earths are closely related to soil moisture and to vegetation. In Alexandra sandy loam, a modal brown-grey earth, under virgin soil conditions no earthworms could be found. Under pasture (sweet vernal, dogstail, some clover) on Alexandra sandy loam, near Alexandra, specimens of *Maoridrilus dissimilis* have been found in October, living at depths of 6 in. to 12 in. No lumbricid species were found in this soil. *M. dissimilis* was probably present before the pasture was planted, and it may therefore be inferred that endemic earthworms are present in very small numbers in undisturbed Alexandra soils. The higher density of plant cover in pasture and consequent increased food supply for earthworms compared with the sparse cover of the virgin soil have probably resulted in an increase of earthworms. The absence of lumbricids must be a result of the dryness of the soil. The common lumbricids of New Zealand soils live among the roots of pasture grasses, very close to the soil surface, and in typical Alexandra soils this habitat would be too dry for them for a large part of the year. Lumbricids are found in small patches, which, because of their micro-relief, are damper than normal. *Allolobophora caliginosa* and *Lumbricus rubellus* have been found in such situations.

Brown-grey earths with slightly higher rainfall than the modal soils tend to have more variety and higher populations of earthworms than the modal soils. However, they still show the effects of low rainfall and prolonged drought. An illustration is afforded by Omarama soils on Old man Range, near Alexandra. Here, *Octochaetus multiporus* is numerous in subsoils which are extensively worm mottled, at sites where the land slopes away from the sun, while at adjacent sites, where the land slopes towards the sun, no earthworms can be found. Loss of moisture by evaporation varies according to the intensity of solar radiation and there is a considerable difference in the moisture conditions at sites like those described. Pairs of sites showing this contrast are found on opposite sides of small ridges and spurs, often only a few hundred feet apart.

Yellow-grey Earths

Yellow-grey earths occupy about 3 million acres; they are the seasonally dry soils of southern Otago, Canterbury, Wairarapa, Hawke's Bay and Manawatu (rainfall about 20 in. to 40 in. per annum).

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Associated with these soils are about ½ million acres of skeletal yellow-grey earths, which lie on the eastern fringes of the cold high country of the South Island. Rainfall is inadequate for optimum plant growth for about a third to a half of the year.

Yellow-grey earth profiles characteristically have greyish, weak-structured topsoil, and yellowish, nutty subsoils, finely flecked brown and grey, overlying a hard, massive "pan" at a depth of about 18 in. The pan appears to have developed in a relatively stable zone of low average moisture content, lying below a more disturbed zone in which the moisture fluctuates widely following rain. (N.Z. Soil Bureau, 1954, p. 24). Rain water percolates down to the pan, where it is held up and can only penetrate further through vertical cracks, which are common in the pan. Subsoil earthworms inhabit the moist, disturbed zone above the pan, and their activities are probably a primary cause of its disturbed nature. The dryness, compactness, and low organic matter content of the pan inhibit the activities of earthworms and neither worms nor their burrows are found in the pan.

Under native vegetation, the earthworm fauna of yellow-grey earths is dominated by subsoil species with few, if any, topsoil species. This has been noted particularly in the South Island, where the fauna of yellow-grey earths is dominated by *Octochaetus multiporus,* which makes extensive, wide burrows at depths of 6 in. or more. *O. multiporus* casts mainly beneath the soil surface and fills disused burrows and natural soil spaces with its castings. It produces the "worm mottling" which is very widespread in South Island yellow-grey earths and also in weakly weathered yellow-brown earths, the moister brown-grey earths, and associated skeletal soils. Most of the area covered by these groups of soils in the South Island supported tussock grassland, much of which has now been converted to exotic pasture. The wide extent of tussock grassland in the South Island is due to the effects of fire (see discussion of area F p. 406). Because of the recent origin of the tussock grassland there is no well defined and characteristic earthworm fauna and the lack of a well defined topsoil earthworm fauna in yellow-grey earths could be attributed to this fact rather than to summer drought. However, it is evident that moisture is a critical factor for earthworms in yellow-grey earths, since the subsoil species show a preference for the shaded and consequently moister slopes, similar to but not as pronounced as that described for Omarama soils (brown-grey earths).

The clearing and sowing to pasture of yellow-grey earths usually has little effect on the endemic earthworms. Topsoil species are eliminated, but these are rare in yellow-grey earths, but subsoil species, which commonly constitute the whole earthworm fauna, are usually unaffected. Lumbricid species, all of which are topsoil dwellers, enter yellow-grey earths when pastures are established. Lumbricids are unable to live in the topsoil during dry periods and they are found, in diapause, in the subsoil. In diapause, the worms construct a burrow, which descends vertically for 12 in. to 18 in. or more and then turns laterally for a short distance, where it expands into a small round chamber. The worm seals this chamber with a layer of compacted soil, lines it with mucus and goes into a resting stage, during which it neither feeds nor moves about, until the return of more suitable conditions of soil moisture in the topsoil. The ability to spend some part of the year in diapause must be a factor of some importance in determining the ability of worms to survive in yellow-grey earths. According to Evans and Guild (1947) *Allolobophora terrestris* f. *longa* has an obligatory diapause,

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and *A. caliginosa* has a facultative diapause. It has been noted that in the yellow-grey earths of Hawke's Bay there is a high proportion of *A. terrestris* in pasture lands compared with other parts of New Zealand. The same tendency has been noted in gravelly soils related to yellow-grey earths in the South Island, but it has not been noted in South Island yellow-grey earths. It may be that the dominant position of *A. terrestris* in these seasonally dry soils is a result of its having an obligatory diapause, as this character may give it an advantage over species which do not have an obligatory diapause. The vertical burrows constructed by earthworms when they go into and emerge from diapause are frequently prominent features of yellow-grey earth profiles. The presence of very active topsoil earthworms in soils that have developed over a long period without any topsoil earthworms may be expected to produce soil changes of some pedological significance. No work has been done on this subject, and it is possible that profile changes due to the change in vegetation from tussock grassland to pasture would obscure any changes due to the activity of earthworms in the topsoil.

Soils Related to Yellow-grey Earths, with Stony or Gravelly Subsoils

Stony soils related to yellow-grey earths cover much of the area of the Canterbury Plains (1½ million acres). Rainfall ranges from about 25 in. per annum near the coast to about 50 in. per annum near the Southern Alps. The soils are mostly free draining and consequently become very dry during summer where rainfall is low or unevenly distributed.

Most of the area of the Canterbury Plains is farmed and the indigenous vegetation has been interfered with to some extent, so it is difficult to find areas in which indigenous earthworms have not been disturbed by human activities. On the western fringe of the plains, in beech (*Nothofagus cliffortioides*) forest on Staveley stony silt loam* (rainfall about 45 in. per annum), *Eodrilus paludosus* and *Octochaetus multiporus* were found at depths of about 6 in. The subsoil was extensively worm mottled and channelled by burrows of *O. multiporus*. Similar earthworm faunas were found in Ruapuna very stony silt loam* (rainfall about 50 in.) under *Poa caespitosa*, Springburn silt loam* (rainfall about 38 in.) under broom and browntop in a small roadside reserve, and Lismore stony silt loam* (rainfall about 29 in.) in a fenced off plantation (young pines with high cocksfoot) beside an old gravel pit. There were no indigenous topsoil species at any of these sites and the fauna closely resembled that of South Island yellow-grey earths. In a number of other stony soils in Canterbury with annual rainfalls of 25 in. to 31 in. no indigenous earthworms could be found.

These stony soils have an indigenous earthworm fauna rather similar to yellow-grey earths and the moister brown-grey earths, but the lower limit of annual rainfall at which indigenous earthworms are found is rather higher in stony soils than in the other groups of soils (about 30 in., compared with about 20 in.). This difference is attributed to the greater susceptibility to drought of stony, free-draining soils compared with other soils.

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*Soil type names from maps to accompany "Soils and Agriculture of the Downs and Plains of Canterbury and North Otago, New Zealand", Soil Bureau Bull. 14 (in preparation). Maps published by N.Z. Soil Bureau (1954).

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Lumbricid species have been collected from all sites sampled on soils with low rainfall (25 in. to 30 in.) and from most of those with higher rainfall. At the time of collecting (late July to early August) worms were found in the top 2 in. or, where the soil was frozen to depths of ¼ in. to 4 in., immediately under the frozen layer. During summer, worms in the drier of these soils must retreat to greater depths and go into diapause. The most common species collected were *Allolobophora caliginosa* and *Lumbricus rubellus*. *Allolobophora terrestris* f. *longa* was common in pasture soils under a rainfall of less than 30 in. per annum and was not found in soils with higher rainfall. It did not appear to dominate the fauna as it commonly does under pasture vegetation in the yellow-grey earths of Hawke's Bay, but it was more common than in the moister parts of New Zealand.

Much pasture land on the stony soils of Canterbury is irrigated, and irrigation considerably affects earthworm populations. At Winchmore Irrigation Research Station, on Lismore stony silt loam (rainfall 27·5 in. per annum) in a plot which had not been irrigated for many years, there were about ½ million worms per acre; in a plot which had been irrigated at 11% total moisture continuously for eight years there were about 1½ million worms per acre; in a plot irrigated at 20% total moisture for eight years there were also about 1½ million worms per acre. Samples were taken from these plots during winter, in July, and population counts cannot be too closely relied on since sampling was not extensive. Most of the worms were concentrated in the top 4 in. in irrigated plots and at 4–6 in. in non-irrigated plots. Greater differences between the earthworm populations of the plots and the distribution of worms within the various horizons of the soil profile would be expected in summer than in winter, and some difference between plots with 11% and 20% moisture might be found during the summer. Species present in all plots were *Allolobophora caliginosa, Lumbricus rubellus,* and *Octolasium cyaneum*. *A. caliginosa* dominated the fauna of irrigated plots. Irrigation promotes the growth of pasture plants, and since lumbricid earthworms feed mostly on dead roots, more growth results in increased food supplies, and this, combined with the direct effect on earthworms of moist conditions in the topsoil, results in higher earthworm populations than in non-irrigated pastures.

Yellow-brown Earths, Weakly Weathered

These soils occupy about 1½ million acres of hilly country in the south of the South Island. Associated with them are about 4¾ million acres of weakly weathered skeletal yellow-brown earths which occupy much of the cold high country on the eastern side of the Southern Alps. Rainfall on these soils is greater than about 40 in. per annum and is well distributed throughout the year, so that there is no long period during the year when evaporation exceeds precipitation. The native vegetation of the soils is tussock grassland. Earthworms have been collected only from the skeletal soils associated with this group.

In Kaikoura loam (as defined by Gibbs and Raeside, 1945) near Lindis Pass (4,100 ft. above sea level) under a close cover of snow tussock (*Danthonia flavescens*) and silver tussock (*Poa caespitosa*), earthworms were numerous and included *Eodrilus montanus* and *Maoridrilus alpinus* in the top 4 in., with *Maoridrilus uliginosus* at depths of 2 in. to 12 in. In Kaikoura stony silt loam (defined in Gibbs and Beggs, 1953) at 3,300 ft., S.E. of Wash Bridge, Wairau Valley,

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under a fairly close cover of fescue tussock (*Festuca novae-zelandiae*) and matagouri (*Discaria toumatou*), earthworms were numerous and included *Maoridrilus ultimus* at depths of 3 in. to 6 in. and *Octochaetus multiporus* at depths of 6 in. to 12 in. The earthworm faunas of these two sites are typical of Kaikoura soils in a relatively undisturbed state, under tussock grassland. In general there is a well developed topsoil and subsoil fauna.

The tussock grassland of much of the area of Kaikoura soils has become depleted as a result of burning and grazing, accelerated soil erosion is taking place, and this has adversely affected the earthworm fauna. At Porter's Pass (3,100 ft.) under a sparse cover consisting of isolated snow tussocks (*D. flavescens*), *Celmisia* sp., turpentine bush (*Dracophyllum* sp.) and mosses, a few specimens of *Maoridrilus modestus* and *M. purus* were found, living in the top 1 in. under moss and among the roots of *Dracophyllum* sp. The fauna of this site is typical of depleted tussock grassland on eroding Kaikoura soils.

Gradwell (1954, 1955) has examined the effects of frost on Molesworth gravelly sandy loam (Gibbs and Beggs, 1953). The area studied was at Molesworth Station, at altitudes of 3,000 to 3,100 ft. above sea level, and the sites were comparable to the Porters Pass site discussed above. The vegetation was depleted tussock grassland (*Festuca novae-zelandiae* dominant). Studies were made of soil temperatures and forms of ice in the soil during winter under bare ground and under tussocks. It was found that only small scattered ice crystals are formed in the soil under plant cover of any kind, while under bare ground the soil may be frozen to a depth of 4 in. Diurnal ranges of temperature at 1 in. depth were approximately halved where the soil was covered or shaded by tussock plants compared with temperatures under bare ground. Similar conditions would prevail over much of the depleted tussock grassland soils of the South Island and could explain the differences observed between the earthworm faunas of depleted tussock grassland and areas with relatively undisturbed and continuous tussock cover.

A small proportion of the area of weakly weathered yellow-brown earths has a cover of beech forest and has a fauna similar to that of the undisturbed tussock grassland soils described above.

Yellow-brown Earths, Moderately Weathered

Intermediate between the weakly weathered yellow-brown earths of higher altitudes and the moderately weathered yellow-brown earths is a group of sub-moderately weathered yellow-brown earths. In the South Island these soils and associated skeletal soils lie on the eastern side of the Southern Alps at lower elevations than the weakly weathered yellow-brown earths and much of their area supports beech forest (*Nothofagus cliffortioides*). They have an earthworm fauna which includes leaf mould, topsoil and subsoil species, and from this stock have apparently been derived most of the species inhabiting the soils of the tussock grasslands east of the Southern Alps. (See discussion of earthworms of area F p. 407). Species found in these soils are characteristically widely distributed. This is attributed to recent climatic and associated vegetational changes; at the last glacial maximum the soils must have been devoid of earthworms and they would therefore have been re-populated by migration along the lower slopes of the

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Southern Alps, from north and south, so recently that there has been insufficient time for extensive differentiation of new species.

Pastures on the submoderately weathered yellow-brown earths have a fauna consisting of the common lumbricid species *Allolobophora caliginosa, Lumbricus rubellus,* and *Octolasium cyaneum.* On the associated skeletal soils, pasture growth is often sparse and populations of lumbricids are very low, e.g. in Tekoa stony silt loam (as defined by Gibbs and Beggs, 1953) near Bealy, under mixed pasture grasses and tussock (*Festuca* sp. and *Poa* sp.) cleared from beech forest about 100 years ago, a very small population of lumbricids was found, living in the top 1 in.

Moderately weathered yellow-brown earths cover about 6 million acres of easy and hilly country in North and South islands. Associated with them is a very large area of moderately weathered skeletal yellow-brown earths, in the North Island. The soils have developed under forest or scrub. Forest types on the soils range from mull-forming broadleaved forest to raw-humus-forming beech forest and podocarp (rimu) forest. Much of the area covered by these soils has been cleared of forest and is now pasture land.

Under forest vegetation indigenous earthworms attain their greatest diversity, and in broadleaved forests there is typically a stratified fauna consisting of leaf mould, topsoil and subsoil species, as described previously (p. 419). Most of the species in each stratum are highly specialised to take advantage of the peculiar features of their habitat. Variations from the pattern typical of broadleaved forest may be correlated with differences in vegetation and micro-climate. Under beech (*Nothofagus truncata*) in Taita silt loam, hill soils (soil set 41 aH, N.Z. Soil Bureau, 1954), leaf mould species (*Neodrilus agilis, Diporochaeta obtusa*), topsoil species (*Maoridrilus ruber, Eodrilus pallidus*) and one subsoil species (*Octochaetus multiporus*) are found. This soil is classified as a strongly leached, moderately weathered yellow-brown earth. There is a close similarity to the fauna under broadleaved forest, but earthworms are less numerous and the same species may be found distributed over large areas, whereas under broadleaved forest species are generally distributed over small areas. In Renata fine sandy loam, a weakly podzolised, submoderately weathered yellow-brown earth, at Mt. Wainui, near Paekakariki, only one topsoil species, *Maoridrilus ruber,* was found living beneath the soil surface, while *Deinodrilus gracilis, Maoridrilus pallidus* and *Maoridrilus ruber* were found living under stones at the soil surface. In Renata silt loam about $\frac{1}{4}$ mile south of Akatarawa saddle, under miro, with about 10 in. of matted raw humus overlying the mineral soil, one small, immature earthworm (*Maoridrilus* sp.) was found living in the humus layer, and no other earthworms nor signs of their activities could be found in the soil. These examples illustrate the effect of the stage of leaching of yellow-brown earths on the earthworm fauna. Similar trends in the strongly weathered yellow-brown earths are discussed below.

Because of the high degree of ecological specialisation of earthworm species in forest soils, the clearing and sowing to pasture of yellow-brown earths developed under forest profoundly affects the earthworm fauna. Leaf mould earthworms disappear, since their source of food is destroyed. Topsoil species also usually disappear, since they also are apparently closely dependent on the type of forest litter. Only subsoil species remain relatively unaffected. The over-all effect is to produce a

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fauna like that characteristic of yellow-grey earths. As the pasture develops, lumbricid species enter and become established in the topsoil, a change that is also paralleled in yellow-grey earths under pasture.

The effect on the earthworm fauna of clearing scrub from a moderately weathered yellow-brown earth and sowing pasture has been described for Taita silt loam, hill soils (type 41 aH, N.Z. Soil Bureau, 1954) by Miller, Stout, and Lee (1955). Observations reported in the paper cover only the decline of native earthworms and do not include the entry and spread of exotic species (which had not at this time arrived).

In the drier yellow-brown earths, lumbricids are forced to go into diapause for some part of the summer, as in the yellow-grey earths.

Gley Podzols

Gley podzols cover about 850,000 acres in Westland and Nelson, where rainfall is 100 in. or more per annum. These soils are the waterlogged counterparts of the podzolised yellow-brown earths and podzols of North Auckland and Southland (Taylor and Cox, 1956). More rain falls on these soils than can percolate readily through the structureless silt loam which covers the subsurface gravels. In such a waterlogged soil, overlain as it is by deep forest litter (9 in. or more deep), a condition of oxygen shortage is produced in the deeper soil layers which is unfavourable to earthworms.

Rimu-miro-kamahi-quintinia forest is typical of gley podzols in Westland (Gibbs *et al.*, 1950). Earthworms are sometimes absent but are usually found in the litter and in the topsoil close to the litter/mineral soil interface, i.e., above the water table. There are no species peculiar to gley podzols—all have also been collected from adjacent soils of other kinds. The fauna is a typical forest-soil earthworm fauna, but lacks subsoil species.

Small clearings known as "pakihis" scattered through forested gley podzols and supporting a vegetation of *Sphagnum* moss, umbrella fern, rushes, sedges and manuka (Gibbs *et al.*, 1950), with the water table perched almost at the surface, are characteristically devoid of earthworms, probably owing to the low concentration of oxygen in the soil water. Removal of forest from gley podzols leads to the development of "pakihi"-like conditions, which now prevail over large areas of the Westland coastal lowlands as a result of the milling of native forests. Attempts to re-afforest or convert to pasture these man-made pakihis have met with little success. The critical feature which prevents re-afforestation appears to be the loss of the surface litter, which, under the previous forest, provided a seed bed for the growth of new forest trees. Without the litter layer, the surface is waterlogged and trees will not grow. Given sufficient time, forest would probably re-invade from the margins and cover pakihis, but the process would be very slow and would depend on the building up of a new litter layer, complete with fauna and microflora, and its gradual extension inwards to the centre of the pakihi. Introduced lumbricid earthworms are occasionally found where pakihi has been converted to pasture, but pastures on pakihi are usually of very poor quality and lack earthworms.

Yellow-brown Earths, Strongly Weathered

Strongly weathered yellow-brown earths occupy about 1¼ million acres in North Auckland. The climate is warm and moist and the soils

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characteristically are clays with thin topsoils and subsoils of low fertility, supporting forest or scrub. The intensity of leaching varies according to the type of vegetation under which a soil has developed; those under broadleaved forest may be little leached, while those under kauri are very strongly leached.

The endemic earthworms of strongly weathered yellow-brown earths are predominantly Megascolecinae (see species list for area A p. 386). Most species are confined to small areas, and are highly specialised in their ecological preferences. They therefore demonstrate clearly the relationship between the stage of leaching of a soil and the earthworms inhabiting that soil. Soils of the Omu suite, yellow-brown earths derived from claystone and shale, illustrate the point. Immature soils (Omu clay loam, soil sets 30a and 30aH, in N.Z. Soil Bureau, 1954) under broadleaved forest have an earthworm fauna with leaf mould, topsoil, and subsoil species. Semi-mature soils (Mata clay, soil sets 40 and 40H), under manuka scrub and rushes, have a well developed subsoil fauna of large sluggish species and virtually no topsoil nor leaf mould species. Further leaching leads to podzolisation and the soils are included in podzolised yellow-brown earths and podzols, strongly weathered. Later semi-mature, weakly podzolised soils (Okaka silty clay loam, soil sets 38, 38H) under manuka scrub, have a subsoil fauna of large species and apparently no topsoil nor leaf mould species. Mature, strongly podzolised soils (Wharekohe silt loam, soil set 47), under stunted manuka scrub and rushes, have a very sparse fauna, which includes only one species, *Rhododrilus sutherlandi,* a long slender species, which lives at depths of 16 in. to 24 in. in the subsoil.

The luxuriance and type of vegetation on these soils is closely related to the stage of leaching of the soils, and the type and quantity of food available to earthworms from plant debris therefore varies with the stage of development of the soil profile. In addition to the effects of differing vegetation, however, differences in soil moisture, clay content and texture also affect earthworms, so faunal differences observed in a series of soils arranged in sequence according to the degree of leaching of the soil minerals may reasonably be attributed to soil differences rather than to differences in any one of these soil characters. Similar trends, related to the sequence of stages of leaching, can be found in other soil suites. Mixed kauri-podocarp-broadleaved forests are found on some North Auckland yellow-brown earths and the stage of leaching of the soil varies from one tree to another. In these circumstances it is possible to find considerable variations in the population density, species composition, and distribution within the soil profile of earthworms, paralleling the variations in plant cover.

Clearing of forest or scrub and planting of pasture on these soils produces an effect similar to that found in other, less weathered yellow-brown earths. The constitution of the lumbricid fauna of these pastures depends on the level of fertility of the soil and consequent pasture vigour. Use of fertilisers so affects the pasture that there may be little relationship between the species of earthworms present and pedogenetic factors.

About 160,000 acres in North Auckland is occupied by strongly weathered podzols developed on sand. These soils are strongly acid, low in nutrients, and have thin topsoils overlying a cemented grey siliceous horizon and subsoil pans of humus and iron which impede drainage. Te Kopuru sand (soil sets 47d, 47dH), under scrub and

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rushes, with 40 in. to 50 in. annual rainfall, is typical of this group of soils. Under native vegetation, no earthworms have been found. In a poor quality pasture growing on this soil, very small populations of *Lumbricus rubellus* and *Allolobophora caliginosa* have been found. These lumbricids must live all the time in the thin layer of topsoil overlying the siliceous horizon, since they would be unable to burrow through the hard siliceous material. Their existence must be dependent on the continuous maintenance of adequate moisture levels in the shallow topsoil. Small variations in depth of topsoil, topography, mean annual rainfall, and its distribution in time are therefore critical in influencing earthworms in Te Kopuru sand and other similar soils.

INTRAZONAL AND AZONAL SOILS

Yellow-brown Sands

Yellow-brown sands cover about ¾ million acres of coastal sand drifts of various ages. They support scrub or sand grass with swamp plants in peaty soils in hollows, and some small areas of forest. They drain freely and are characterised by extreme shortage of moisture in summer. Their susceptibility to drought is their most important character as far as earthworms are concerned.

There do not appear to be any endemic earthworm species peculiar to yellow-brown sands. Forested soils support a typical forest-soil earthworm fauna, but the presence of forest indicates a lack of excessive seasonal dessication and this is the critical requirement for earthworms in yellow-brown sands. The species at forested sites are the same as those found in adjacent forested soils on other soil types. Since yellow-brown sands occupy narrow coastal strips and are adjoined by soils of other types, frequently forested, there is usually a readily available source of species to populate small areas within the yellow-brown sand areas that can provide suitable conditions for the existence of forest earthworms.

Pastures on yellow-brown sands are populated by the common lumbricids *Allolobophora* spp., *Lumbricus rubellus,* and *Octolasium cyaneum.* Micro-relief, as a cause of differences in freedom of drainage, limits the activities and population densities of pasture earthworms. Earthworms may be present in slight hollows or on shaded aspects of ridges and absent on nearby slight rises or sunny areas. The effect of the soil texture is to produce an environment typical of a lower rainfall than is actually experienced. The situation is comparable to that found in yellow-brown pumice soils, in that the soils are derived from recently deposited uncompacted material with little clay and have been discontinuously populated by earthworms from surrounding areas. The effects of drought are more marked than is general in yellow-brown pumice soils, since the yellow-brown sands are found in areas with lower rainfall than the yellow-brown pumice soils.

Yellow-brown Pumice Soils

Yellow-brown pumice soils occupy about 4 million acres, covering most of that portion of the North Island within a radius of 50 miles of Lake Taupo and extending northward to Bay of Plenty and eastward almost to Gisborne.

The indigenous earthworm fauna of yellow-brown pumice soils is dominated by a few species of *Rhododrilus,* all of which are topsoil

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dwellers. There are usually no subsoil earthworms, and leaf mould species are only occasionally found under forest. The very recent deposition of the rhyolitic pumice, which is the parent material of these soils, is the basic cause of the peculiarities of distribution of earthworms in the soils.

The pumice has been deposited within the last 1,700 years (Ferguson and Rafter, in Baumgart, 1954). Most of it was deposited in large cataclysmic showers of hot ash, which destroyed the vegetation as it fell. The soils derived from the pumice (Area D, Fig. 368) have been populated by earthworms that have entered from surrounding areas (see discussion of area D p. 402). The pumice soils are generally coarse in texture, with little clay, free draining, and subject to drought in summer. Most of their area is tussock grassland or scrub covered, with isolated patches of forest. Rainfalls range from 40 in. to 100 in per annum, but because of the free draining, relatively unweathered nature of the soil and the short time that has elapsed since the vegetation became established, conditions superficially resemble those of lower rainfall areas. The physical conditions have acted as a highly selective barrier to the dispersal of earthworms. A few species of *Rhododrilus* dominate the fauna. There is little or no difference between the earthworm faunas of forest, scrub, and tussock grassland soils. Population densities are frequently very low, but occasionally are high, e.g. at Waiouru, in Taupo light sandy loam (soil set 18g, in N.Z. Soil Bureau, 1954), derived from shallow Taupo ash overlying Tongariro ash, under red tussock (*Danthonia rigida*) and fescue (*Festuca novae-zelandiae*), the earthworm population was about 300,000 per acre, composed almost entirely of *Rhododrilus robustus*.

When yellow-brown pumice soils are cleared of their native vegetation and sown to pasture, the replacement of native earthworm species by lumbricids is slower than in yellow-grey or yellow-brown earths. A series of collections from Taupo sandy silt (soil set 18, in N.Z. Soil Bureau, 1954) in the Waikite-Ngakuru area, south of Rotorua, illustrate the replacement process. Under the original vegetation (manuka, bracken, some tussock) a small population of *Rhododrilus similis* was found. Nearby, the land had been developed, or was being developed, for dairy farming. Samples of the earthworm fauna were taken from land in various stages of development from first clearing to long established pasture. It was found that the removal of the native vegetation caused the extinction of *R. similis*. In pastures up to about three years old no earthworms were found, but as the pasture developed further and the "humus buildup" at the surface became deeper, lumbricid species appeared. First to appear was *Octolasium cyaneum*, a large, sluggish species commonly found in the topsoil of low fertility pastures on many soil types, and in soils under regenerating scrub where pasture has deteriorated. After four or five years of pasture development, *Lumbricus rubellus* was commonly found with *O. cyaneum*. In some pastures *L. rubellus* subsequently increased in numbers and almost entirely replaced *O. cyaneum*, but more commonly, as the fertility of the pasture was built up and the humus-stained topsoil layer increased in depth, *Allolobophora caliginosa* or *Allolobophora terrestris* f. *longa* (sometimes both species) became established and usually dominated the earthworm fauna. Total earthworm populations rose as these changes took place. In a soil where only *O. cyaneum* was present, populations of the order of 100,000 per acre were found, while in highly fertile pastures

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with faunas dominated by *A. caliginosa* or *A. terrestris,* numbers were of the order of one to two millions per acre. At the latter stage, there was a close resemblance to the normal state of affairs in fertile pastures on yellow-brown earths.

During the last forty years, large areas of yellow-brown pumice soils have been planted with exotic forest trees (mainly pines). The largest continuous forests extend from near the northern boundary of the yellow-brown pumice soils southwards, well into the area covered by the Taupo pumice. In these forests, deep litter provides a source of food for earthworms, and the continuity of uniform vegetation, together with closely similar soil conditions, have greatly facilitated the dispersal of earthworms. The most remarkable feature of the earthworm fauna of exotic forest yellow-brown pumice soils is the presence of both indigenous and exotic earthworm species. This is the only habitat known in New Zealand where the two groups are found together over an extensive area. There is no distinct leaf mould fauna; *Rhododrilus similis* and *Diporochaeta obtusa* are sometimes found at the leaf mould/topsoil boundary, but more often there are no leaf mould earthworms. The topsoil fauna consists of the lumbricids *Allolobophora caliginosa, Lumbricus rubellus* and occasionally *Octolasium cyaneum,* together with endemic species, most commonly *Rhododrilus similis* and *Diporochaeta obtusa,* with, less frequently, other species of *Rhododrilus* and also *Deinodrilus agilis.* Subsoil species are usually absent, but *Megascolides fuscus* has been collected from the subsoil in a few places. The constitution of the native section of the fauna varies little from that found in similar soils under native vegetation, so the physical characteristics of the soil that restrict the entry and spread of species under native vegetation must still be effective under exotic forest. Under normal conditions, patches of native forest seem to act as small centres from which endemic species disperse into the surrounding scrub and tussock. The very extensive pine forests will probably perform the same function and also provide a stock of lumbricids to colonise newly established pasture lands.

Yellow-brown Loams

Yellow-brown loams cover about 4 million acres in the vicinity of Mt. Egmont and in Waikato. Associated with them are some skeletal yellow-brown loams in Taranaki, extending from near Mt. Egmont to the western edge of the Taupo pumice soils and northward to Waikato. The soils are derived from fine-textured volcanic ash and have clays high in alumina.

The earthworm faunas of yellow-brown loams closely resemble those of moderately and strongly weathered yellow-brown earths. In forested areas there is a stratified, forest earthworm fauna, with leaf mould, topsoil and subsoil species. The faunas of areas with other than forest vegetation closely parallel those of moderately and strongly weathered yellow-brown earths with similar vegetation.

Red-brown Loams and Brown Granular Clays

These soils cover about 1¼ million acres, mainly in North Auckland and Coromandel districts. The sequence of fertility, due to leaching and related to age and vegetation, which runs to a greater or lesser extent through all soil groups is, in this group, most marked. (N.Z. Soil Bureau, 1954, pp. 40–48). There is a series of vegetation types, from

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broadleaved forest, to podocarp-broadleaved forest, to podocarp-kauri forest, to kauri forest, to manuka scrub and rushes, paralleling the stages of leaching and development of the soil. Associated with this series of vegetation types is a change from mull under broadleaved forest to raw humus under kauri forest, and to little or no litter accumulation under scrub and rushes. There is no shortage of moisture in red-brown loams and brown granular clays, and differences between the earthworm faunas of various soils are attributable to soil differences and associated vegetational and humus differences.

Soils of the Te Kie suite, brown granular clays derived from shattered dolerites, breccias and tuffs, illustrate relationships between soils and earthworms. An immature soil, Awapuku clay loam (soil sets 87, 87H, in N.Z. Soil Bureau, 1954), under podocarp-broadleaved forest, has a well developed leaf mould, topsoil, and subsoil fauna. A semi-mature soil, Waimatenui clay, under podocarp-broadleaved forest, has a similar fauna but with less variety of species. Another semi-mature soil, Mangonui clay (soil set 89), under bracken and low scrub, has practically no litter and has only subsoil species. A late semi-mature soil, Rangiuru clay (soil set 90H), under bracken, manuka, *Hakea* and rushes, has a sparse fauna, consisting of only one subsoil species. A mature, podzolised brown granular clay, Tinopai sandy clay, under manuka and rushes, has also a very sparse fauna consisting of only one species.

The young to immature red-brown loams have moderate to high natural fertility and most of the area covered by these soils has been cleared of the broadleaved forest under which the soils were formed. Only small, isolated remnants of forest remain, usually surrounded by pasture, unfenced and used for shelter by stock. Under such a forest remnant (taraire, kohekohe, puriri) on Kiripaka bouldery silt loam (included in soil set 95 in N.Z. Soil Bureau, 1954) there was a high population of earthworms, including the indigenous species *Megascolides irregularis* and the exotic *Allolobophora caliginosa*. A similar situation was found in a small forest remnant on Maunu silt loam (included in soil set 95), *Megascolides maoricus* (indigenous) and *Lumbricus rubellus* (exotic) were collected. In an "ironstone soil", Okaihau gravelly clay (soil set 97a), a strongly leached brown loam derived from basalt, no endemic eathworms could be found under bracken and scrub but there were a few specimens of the lumbricid *Octolasium cyaneum* near the fringe of adjacent pastures. In pastures on this soil, grass growth is not vigorous and small populations consisting entirely of *Octolasium cyaneum* have been found.

Pastures on red-brown loams and brown granular clays have a fauna similar to that of yellow-brown earths and other soils not subject to drought.

Organic Soils

Extensive peats formed on mountain sides by slow decomposition of organic matter, owing to low temperature and high rainfall rather than to a local high water table, are termed zonal organic soils (see soil map of New Zealand (Taylor, 1948) for distribution of such soils). These zonal peats, in Stewart Island and Southland, have earthworm faunas similar to those of mineral soils on similar sites, i.e. a stratified forest fauna. The fauna of the zonal peats of the isolated subantarctic

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islands consists of only a few species that do not show any high degree of ecological specialisation.

In contrast to the zonal peats, intrazonal peats are deposited in hollows with impeded drainage. The high water table and associated anaerobic or near anaerobic conditions prevailing in these soils considerably affect earthworms. Species living in such peat deposits are found in patches raised slightly above the general level of the ground surface, or in an aquatic or semi-aquatic environment in and about pools of surface water. There do not seem to be any endemic Megascolecidae restricted to peats of this kind. The earthworm fauna consists rather of an incomplete sample of the fauna of surrounding areas of mineral soils. A tubificid *Pelodrilus bipapillatus,* is commonly found in swamps and bogs in North and South Islands and is rarely found in other habitats. This is a semi-aquatic species in peat swamps, found sometimes in surface water and sometimes in peat close to the surface.

The pH of peats imposes limits on the activities of earthworms. In North Auckland, many peats have a pH of 3 to 4 and no endemic earthworms have been found in them. In Hawke's Bay, peats of the Poukawa series (Pohlen *et al.,* 1947) contain lime washed in from surrounding limestone deposits and from beds of fresh water shells, and have a pH of about 8. These soils, which have been partially drained, have an endemic earthworm fauna closely similar to that of the surrounding mineral soils.

When peats are drained and sown to pasture, with topdressings of lime where necessary to raise the pH, large populations of *Allolobophora* spp. and *Lumbricus rubellus,* with some other lumbricid species as minor elements in the fauna, are commonly found.

Gley Soils

The small amount of collecting done on gley soils indicates that conditions are generally similar to those in intrazonal peats, i.e. anaerobic or near anaerobic conditions prevail beneath the high water table and the activities of earthworms are confined to the superficial soil above the water table. In gley soils near the eastern edge of the Canterbury Plains it was noted that earthworms in pastures (*Allolobophora caliginosa* and *Lumbricus rubellus*) make deep burrows, penetrating below the winter water table, to which they apparently retreat during the dry summer months when the topsoil is dry and the water table may be at a depth of several feet. This is probably quite a common phenomenon in gley soils.

Saline Gley Soils

Saline gley soils do not appear to have a characteristic indigenous earthworm fauna. One species, *Rhododrilus cockaynei,* has been collected from a saline gley near Dunedin. This species is most common on New Zealand subantarctic islands, where it is found on and adjacent to the sea shore. It is apparently transported from island to island with floating debris and its distribution pattern is related to the direction of ocean currents. There are only small, isolated areas of saline gley soils in New Zealand, in river estuaries and coastal depressions. Their discontinuity would inhibit the wide dispersal of any species fitted to live in saline conditions.

Where saline soils have pastures growing on them, introduced lumbricids are found. *Allolobophora terrestris* f. *longa* is the most

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common species. The special characteristics of behaviour that make it possible for *A. terrestris* to tolerate saline conditions have been noted previously (p. 421).

Recent Soils from Alluvium

Recent soils from alluvium cover about 1½ million acres. Most alluvial soils have high natural fertility and are favourable for plant growth. Consequently they are also favourable for soil organisms and have high endemic or exotic earthworm populations with a great variety of species. The activities of earthworms are occasionally inhibited by lack of oxygen where there is a high water table, or by summer drought in stony alluvial soils, but otherwise alluvial soils are a most favourable environment for earthworms.

The incorporation of fresh alluvial material into the existing soil is largely the work of earthworms. This is particularly so with exotic species in pastures; examples have been found on the Gisborne flats where silt deposited on pastures to a depth of 3 in. in 1948 was, at the end of 1949, extensively mixed with the humified older deposits by earthworm activities and channelled by earthworm burrows, which penetrated through the new silt deposits into the underlying, older deposits. Similar examples are found wherever recent flood deposits have been laid down over older deposits with pasture vegetation. The species involved in the example were lumbricids, but under native vegetation the same results are achieved by native earthworm species. In a very recent silt deposit about 6 in. deep, under kahikitea and tawa forest in a small stream valley about 3 miles south of Tolaga Bay, *Leucodrilus digitocystis* and *Rhododrilus disparatus* were found moving up and down through the new silt deposit and mixing it with the forest leaf mould, which had covered the former surface.

Experiments conducted on Manawatu silt loam (set 1, alluvial soils, in N.Z. Soil Bureau, 1954) by Waters (1955) on population densities and seasonal population changes of *Allolobophora caliginosa* and *Lumbricus rubellus* under a pasture consisting of perennial rye grass and white clover showed that populations between three and five million per acre were present.

Recent Soils from Volcanic Ash

Recent soils from volcanic ash cover about 1¾ million acres and comprise soils formed on material at present accumulating around the active volcanoes Ruapehu and Ngauruhoe and on the material ejected in recent small eruptions.

The only soils of this group that have been examined are those formed on pumiceous material ejected from Mt. Tarawera and mud from Lake Rotomahana ejected during the Tarawera eruption of 1886. Where Rotomahana mud overlies coarse Kaharoa pumice, under forest vegetation, indigenous megascolecine species are found in topsoil and subsoil, although they are absent or very rare in adjacent areas of soils derived directly from Kaharoa pumice. Soils derived from Tarawera ash, which is a coarse gravelly material, have very few earthworms. These differences are attributed to the finer texture of the Rotomahana mud compared with Kaharoa and Tarawera ash and consequent more favourable conditions for earthworms in Rotomahana soils.

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Steepland Soils

Steepland soils occupy about half the area of New Zealand. They are divided into groups, corresponding to the brown-grey earths, yellow-grey earths, yellow-brown earths, etc., and have been discussed with these groups of soils.

Mountain Soils, Bare Rock, and Ice

Mountain soils, bare rock, and ice occupy about 2½ million acres at high elevations.

In the North Island, earthworms have been collected from mountain soils on the Tararua and Ruahine ranges and from Mt. Egmont. They have been found at heights up to 5,000 ft. on the Tararua Ra. and on Mt. Egmont. Species collected are not peculiar to mountain soils, but comprise a reduced representation of the fauna of lower levels on the same mountains. They are found at heights where snow lies in winter, but since they are species that live for the most part in the subsoil they would be insulated by the overlying topsoil from low surface temperatures when the ground is snow covered. Individual species are widely distributed, e.g. *Deinodrilus montanus* is found on the Tararua Ra. and Mt. Egmont, and *Maoridrilus montanus* occurs on the Tararua and Ruahine ranges. The upper limit of their occurrence seems to extend to the upper limit of vegetation.

In the South Island, little work has been done on mountain soils. One hundred feet above the upper forest limit on Mt. Misery, near Arthur's Pass, a few specimens of *Maoridrilus modestus* were found close to the ground surface under clumps of *Celmisia, Hebe, Dracophyllum,* and *Cyathodes,* but none could be found beneath bare ground between clumps of vegetation. Much of the high mountain country of the South Island is almost devoid of vegetation and probably has no earthworm fauna.

SUMMARY

ZONAL SOILS

Relationships between endemic earthworms and the main zonal soils of New Zealand, with reference to climate and vegetation are summarised in Fig. 370. In the figure the main zonal soils are arranged in sequence, commencing with the semi-arid brown-grey earths and continuing through the yellow-grey earths with prolonged seasonal moisture deficits, to the yellow-brown earths, in which seasonal moisture deficits are not important in soil processes. Correlated with the soil sequence is a sequence of changes in the vegetation. There are no sharp divisions between the major soil groups. All may be arranged in a continuous series with hydromorphic and xeromorphic soils linking the modal soils of the various groups.

Paralleling the series of soil changes is a series of changes in the constitution, population density, and vertical distribution within the soil profile, of endemic earthworms.

In modal brown-grey earths there are few earthworms and all apparently live in the subsoil. In hydromorphic brown-grey earths and xeromorphic yellow-grey earths, there is an increasing incidence of subsoil species; occasionally, topsoil species are found. Small differences in soil moisture, correlated with differential shading and differences of slope and aspect, are critical in determining the suitability of habitats

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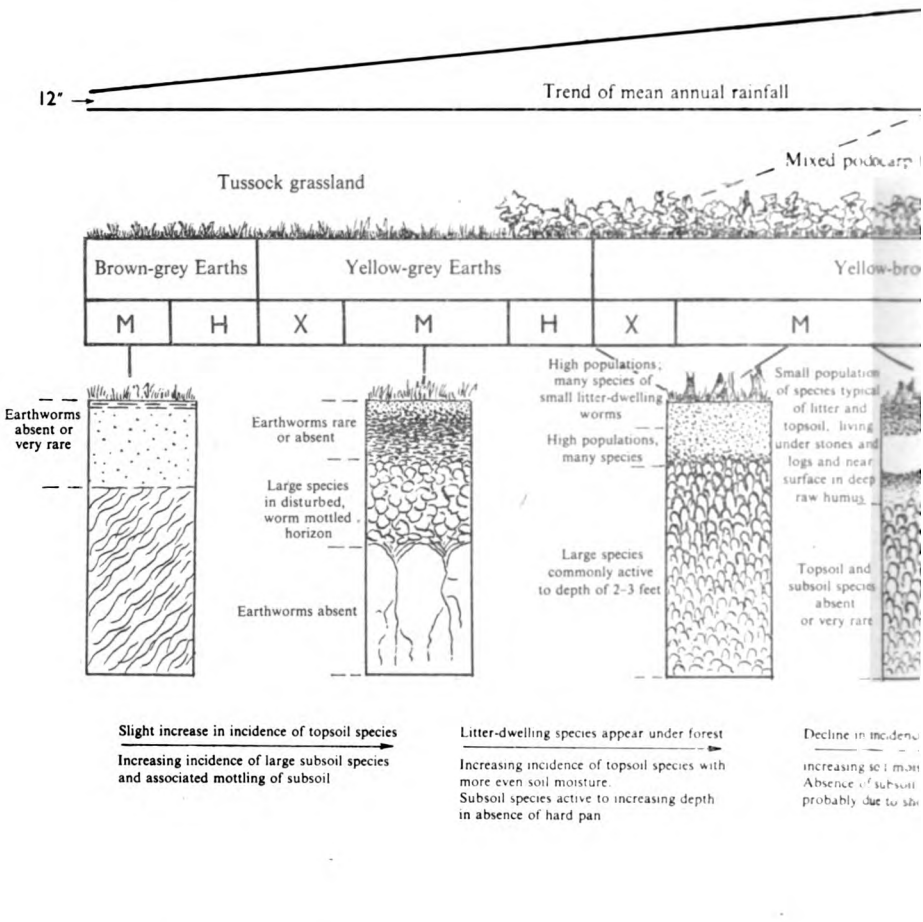

M		Modal soils of the groups
X	H	Drier and moister soils linking with the modal soils
T		Warmer soils mean annual temperature 57°F approximately
C		Colder soils mean annual temperature 42°F approximately
P		Podzolized soils under mor forming trees

FIG. 370. Relationships between endemic earthworms and mai
climate and vegetation. (Adapted from Taylor, 1952

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for earthworms. In modal yellow-grey earths the fauna consists principally of large subsoil species, living in the disturbed horizon above the clay pan. Topsoil species are often absent, but are found more frequently than in drier soils.

In the hydromorphic yellow-grey earths there is a change from tussock grassland to forest as the characteristic vegetation type. Most endemic New Zealand earthworms are found in forests, where they have attained a high degree of ecological specialisation and morphological diversity. The species found in tussock grassland have apparently come from adjacent areas of forest and there are few species peculiar to tussock grassland soils. A typical forest soil has an earthworm fauna consisting of leaf mould, topsoil, and subsoil species. All three groups achieve their greatest development in modal yellow-brown earths under broadleaved forest. In yellow-brown earths, in the absence of clay pans, subsoil species are active to greater depths than in yellow-grey earths. The strongly weathered yellow-brown earths have a fauna dominated by Megascolecinae, and the moderately weathered a fauna dominated by Acanthodrilinae, but species in many ways analogous occupy similar ecological niches in strongly and moderately weathered soils.

Increasing rainfall, in the hydromorphic yellow-brown earths, leads to progressive reduction in population density and variety of species. The effect of excess moisture is most obvious in gley podzols, where there are no subsoil species and very few leaf mould and topsoil species. This is probably due to lack of dissolved oxygen in the soil water. The position is comparable to that found in gley soils and peat bogs, but in the gley podzols the soil is saturated because of the very high rainfall, while in gley soils and peat bogs the soil is saturated because drainage is impeded.

In the weakly weathered yellow-brown earths, formed under tall tussock grassland, the fauna resembles that of modal yellow-grey earths, but with the addition of a well developed topsoil fauna. Small scale differences in the environment are critical for topsoil species in these soils; under individual tussock plants, soil frost is not as severe as in the spaces between tussocks (see Gradwell, 1954, 1955) and this is probably the reason for earthworms (particularly topsoil species) being more common under tussocks than between them.

Podzolisation, which occurs under trees producing raw humus in the moderately and strongly weathering yellow-brown earth zones, adversely affects earthworms. Leaf mould species and, in some North Auckland podzols, subsoil species are found in very small numbers. The acidity and high fibre content of the plant litter and acidity of the underlying mineral soil are probably the critical factors limiting the activities of earthworms.

INTRAZONAL AND AZONAL SOILS

The non-zonal impress is different in each group of intrazonal and azonal soils and distinguishes the soils of any one group from those of all the others.

Yellow-brown loams, red-brown loams, brown granular clays, and most of the recent soils from alluvium have endemic earthworm faunas closely resembling those of adjacent zonal soils with similar vegetation.

In the yellow-brown sands, yellow-brown pumice soils, recent soils from volcanic ash, and coarse textured and stony soils from alluvium,

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there is little clay and the coarse physical texture of the soil imposes limits on the activities of earthworms and may exclude them altogether (e.g. in some soils derived from Taupo pumice). In addition to the direct effects on earthworms of their texture, most coarse textured soils are free draining and dry more quickly and severely than other less free-draining soils. Such soils under a high rainfall may have an earthworm fauna with many features characteristic of the fauna of soils under lower rainfalls.

In intrazonal organic soils, gley soils, and saline gley soils, the earthworm fauna is influenced by the groundwater, which is low in oxygen content and is close to the surface, so that earthworms are able to live only in immediate proximity to the ground surface. In saline gleys, salinity excludes some species and favours other species that are able to live under the conditions.

In pastures and cultivated lands, indigenous earthworms are largely replaced by exotic species, mostly of the family Lumbricidae. Since lumbricid earthworms feed on dead root and leaf material from pasture grasses, the composition and population density of the lumbricid fauna in pastures are related directly to the level of fertility and species composition of the pasture, with some slight variations due to differences in the moisture regime, e.g. in yellow-grey earths compared with yellow-brown earths. Levels of pasture fertility may be greatly modified by the use of fertilisers, and the species composition of New Zealand pastures shows a high degree of uniformity. The composition of the earthworm fauna of pasture lands is therefore related rather to differing standards of field husbandry than to soil differences, although soil differences sometimes influence the earthworm fauna to some extent.

ECOLOGY AND DISTRIBUTION IN RELATION TO SOIL-FORMING FACTORS

PARENT MATERIAL

The parent material from which a soil is derived usually has little direct effect on the earthworms that live in the soil. It is only where the parent material has some unusual character dominating the soil environment, i.e. in some intrazonal and azonal soils, that earthworms are affected.

The influence of parent material on earthworm ecology may be due to its physical nature, or its chemical nature, or to a combination of both.

In soils derived from Taupo and Kaharoa pumice the coarse texture of the parent material is an important factor in limiting the activities of earthworms. Apart from the direct effect of the coarse particles, the nature and distribution of vegetation types is also influenced, and this in turn influences earthworms. The nature of the barrier to the dispersal of earthworms constituted by pumice soils has been discussed previously.

Soils derived from dunite and serpentine, in the "mineral belt" of Nelson, have very few earthworms. In a sandy silt derived from dunite on a slope of about 15° to 20°, in the Lee River valley, a very sparse population of *Maoridrilus nelsoni* was found; an adjacent convex slope, where soil moisture was more plentiful and the soil was deeper, supported a slightly higher population of *Octochactus pelorus*. At both sites the worms were close to the surface among the roots of manuka and bracken. Vegetation on soils derived from dunite is sparse and

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stunted and this is attributed to the toxic effects of the high magnesium and chromium and low calcium content of dunite, and consequently of the soils derived from it. Whether the presence of toxic substances in the soils, derived from the parent material, or the associated sparse vegetation and consequent shortage of food is the primary cause of the low population density of earthworms is not known.

In soils with saline groundwater earthworms are excluded or can only survive by adopting special behaviour patterns (see discussion of behaviour of *Allolobophora terrestris* f. *longa* in saline soils, p. 421). The high osmotic pressure of strong saline solutions and their consequent dehydrating effect on animal tissue accounts for the exclusion of earthworms from soils with strongly saline groundwater.

TOPOGRAPHY

Topography affects earthworms through its effects on soil depth and drainage. Generally, a series of samples taken from the top of a ridge and proceeding down a slope to a valley shows progressively deeper soil, more luxuriant plant growth, and higher populations of earthworms.

Small changes in topography frequently affect the micro-climate, since the land may slope towards or away from the sun. The occurrence of *Octochaetus multiporus* in deep soils on shaded slopes in brown-grey earths and yellow-grey earths and its absence from nearby areas exposed to the sun has been commented on previously (p. 426). This is primarily an effect of topography.

Small hollows, although they usually have deeper soils than surrounding areas, may have a reduced earthworm population including species not known from adjacent higher ground, because of impeded drainage and consequent bog formation and anaerobic conditions in the soil. In a small swampy patch with a high water table, on the Old Man Range, near Alexandra, specimens of *Eiseniella tetraedra* were obtained. The small swamp was surrounded by Omarama stony sandy loam, a brown-grey earth (Gibbs and Raeside, 1945) with a very low earthworm population, which did not include *E. tetraedra*. The same species was collected from a small, narrow strip of bog on a reversed slope caused by slumping on the face of a terrace edge in the Awatere River valley. This bog was adjacent to an area of Hillersden stony silt loam, a yellow-grey earth (Gibbs and Beggs, 1953). *E. tetraedra* is a semi-aquatic lumbricid, found in streams and swamps and rarely in pastures. Its occurrence in isolated small bogs must be dependent upon chance transport across surrounding areas unfavourable for the species.

CLIMATE

Macro-climatic effects act on earthworms over large areas, through their effects on vegetation and soil processes; micro-climatic effects act directly on individual earthworms and small groups of earthworms living in a particular ecological niche.

Macro-climatic effects, through their influence on vegetation and soils, and within the limits set by the past and present disposition of land and sea, mountain building and volcanic activity, have been primarily responsible for the present over all distribution pattern of endemic earthworms in New Zealand. (See previous discussion of earthworm distribution).

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The relationship of earthworm distribution and ecology to macro-climatic differences is illustrated in a study of the earthworm fauna of a typical North Island mountain side. Changes in the fauna are represented in Fig. 371. The general tendency is towards a reduction in number of species and population density from lower to higher levels on the mountain side. In the Rimutaka-Tararua mountain chain, in rain forest on the lower slopes the dominant subsoil species is *Octochaetus multiporus,* with species of *Maoridrilus* (*M. ruber, M. carnosus, M. pallidus*) and *Deinodrilus montanus* dominant in the topsoil and species of *Neodrilus* (*N. agilis, N. polycystis*) and *Diporochaeta obtusa* dominant in the leaf mould. Higher up, in the sub-alpine forest, *O. multiporus* and *Maoridrilus montanus* are found in the subsoil, *M. carnosus* and *D. montanus* in the topsoil, and a reduced fauna consisting of *D. obtusa* and *Neodrilus* spp., in the litter. Above the upper forest limit, in the soils of the tussock covered mountain tops, the only species known is *Maoridrilus montanus,* a very large species, found only in the subsoil at lower levels, but in topsoil and subsoil at higher levels. Mt. Egmont shows a similar sequence of changes, but differing from the Rimutaka-Tararua sequence in that the mountain is higher and *Deinodrilus montanus* is found above the upper forest limit in soil under mosses and herbs at elevations up to 5,000 ft. Climatic variations are not directly responsible for the changes described, but indirectly, as they affect the vegetation and consequently the quantity and type of plant litter available as a food supply for earthworms.

Earthworms are unable to tolerate desiccation, and consequently the amount and distribution in time of rainfall are important to them. Pickford (1937, p. 32) states that practically all the localities from which endemic acanthodrilines have been recorded in South Africa fall within regions with an average annual rainfall of over 20 in. She also states that in south coastal regions, where the rainfall is fairly evenly distributed through the year, several species are recorded close to the 20 in. isohyet, whereas in Natal and Transvaal, where the rainfall is discontinuously distributed, the acanthodriline records are delimited by the 25 in. or even the 30 in. isohyet. The mean annual rainfall of eastern South Island (area F in Fig. 368) is between 20 in. and 30 in. and in some places it is less than 20 in. (Kidson, 1950). There is no lack of endemic Megascolecidae in this area. Near Alexandra, where rainfall is less than 20 in., earthworms are found on shaded slopes, but not usually on sunny slopes, which in general have a very sparse cover of vegetation. In these areas rainfall is discontinuous and dry spells are frequent. The mean annual temperature, however, is between 50° and 55°F., while South African temperatures are higher (over 70°F. in inland areas, so that the moisture deficit of the South African soils would be greater than that of the New Zealand soils, and consequently the rainfall would have to be greater than in New Zealand to maintain comparable soil moisture conditions. Soils under pasture in the dry areas of New Zealand have high lumbricid populations. The Lumbricidae, because of their ability to go into diapause in the subsoil when the topsoil is too dry for their activities, are well fitted to tolerate seasonal drought.

The effects of micro-climatic variations are most important to earthworms. An individual worm can and does tolerate very adverse conditions for a short time, while it gathers food or moves about, provided it can retreat to more favourable conditions for most of the time.

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Where the individual worm spends most of its time, all the conditions essential for its existence must be satisfied, but these conditions need only prevail in a space large enough to accommodate the earthworm's body. Earthworms may be found, for instance, living in small accumulations of soil in cracks in otherwise bare rock outcrops (e.g. *Maoridrilus rubicundus,* living in a rock cleft at 5,000 ft. at Mokai Patea), under cushions of moss on otherwise bare ground (e.g. *Acanthodrilus kermadecensis,* close to the mouth of a fumarole at Raoul Island), under stones and logs on and adjacent to ocean beaches (e.g. *Allolobophora caliginosa* and *Octolasium cyaneum* at Little Barrier Island). Variations of micro-relief, drainage, temperature, humidity, wind effects, soil acidity, height and type of vegetation, depth of plant litter, are all highly significant, even when they are on a minute scale.

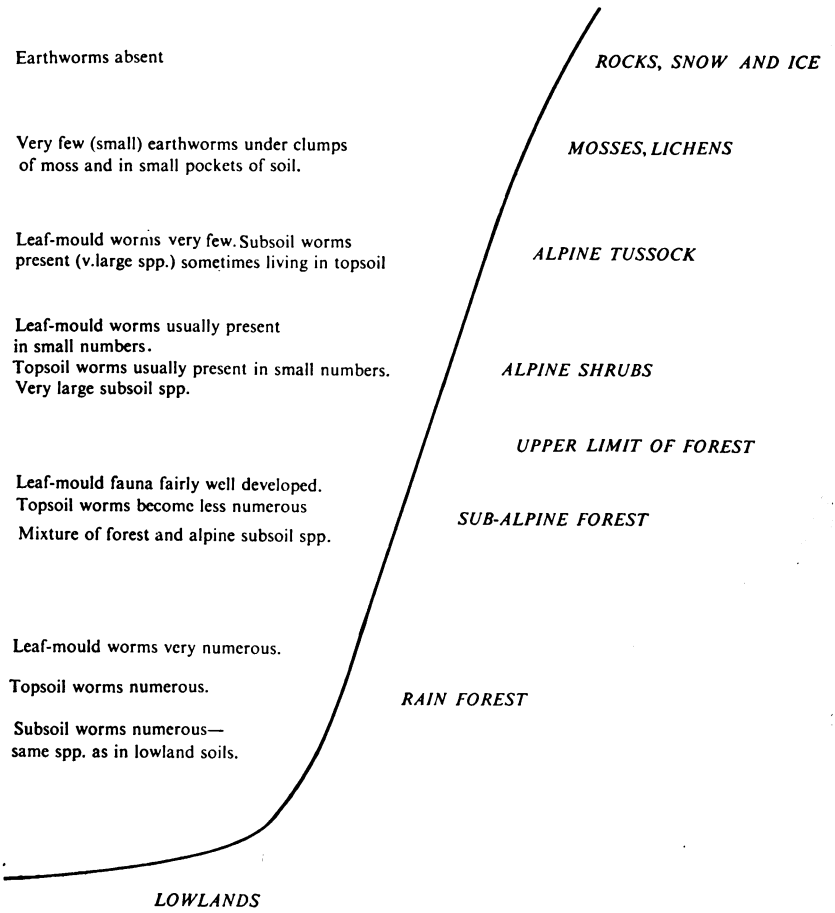

FIG. 371. Relationships between earthworms and vegetation types on a typical North Island mountainside

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The distribution and ecology of earthworms are greatly affected by the biological processes which contribute to soil formation. The activities of earthworms are themselves a part of the biological regime of soil and cannot be entirely separated from those of other animals or plants that contribute to the process of soil formation. For convenience, however, the discussion is divided into two parts – the influence of vegetation on earthworms and the activities of earthworms as they affect the physical and chemical characteristics of the soil.

Relationships between Earthworms and Vegetation

The effects of vegetation on earthworms may be divided into those due to the density of plant cover and those due to the various types of plant cover and associated humus types.

The influence of density of cover only becomes apparent when the cover is sparse. Under a sparse cover there is a tendency towards concentration of earthworms under individual plants and a lack of earthworms where plant cover is absent. This is illustrated by the fauna of samples taken from Omarama stony sandy loam (soil type from Gibbs and Raeside, 1945) on Old Man Range, near Alexandra. On a dry slope, with N.W. aspect, the ground surface was predominantly bare and stony, with patches of scabweed (*Raoulia* sp.) and some tussock plants (*Poa* sp.). Under the bare ground surface no earthworms could be found. Under *Raoulia,* where there was about an inch of humus and fine mineral material, no earthworms could be found. Where a very small *Poa* tussock was established in a patch of *Raoulia* and there were 3 to 4 in. of topsoil, no earthworms were found, but grass grubs (larva of *Odontria* sp.) were found immediately under the tussock plant. Under a larger *Poa* (about 4 in. diameter at ground level) growing in a patch of *Raoulia,* there were about 8 in. of topsoil and specimens of *Maoridrilus dissimilis, Eodrilus paludosus* and *Allolobophora caliginosa,* together with grass grubs (*Odontria* sp.) and a coleopteran were found directly under the tussock plant. Where *Poa* and *Festuca* tussocks were well established on deeper and moister soil in a small dimple on the hillside, *Maoridrilus dissimilis, Eodrilus paludosus* and *Allolobophora caliginosa* were numerous in the upper eight inches of the soil but were concentrated more in the vicinity of individual tussock plants than under bare ground or very short vegetation between tussocks. Shortage of moisture regulates the nature and distribution of plants at this site; the plants, in turn, since they are the source of food for earthworms, regulate the earthworm fauna. This example illustrates an extreme case of the effect of density of plant cover. Similar tendencies are found wherever there is a discontinuous plant cover, but they are usually not as obvious.

The prolonged geographical isolation of New Zealand and the predominance of forest vegetation have resulted in the development of a forest earthworm fauna, with species highly specialised to occupy particular ecological niches in particular types of forest. Stratification of the earthworm fauna of forest soils into leaf mould, topsoil, and subsoil species has been described previously. Stratification of the fauna is not well developed in all forest soils; its degree of development is related to the forest type and the associated humus type. Kubiena (1953) classified humus types according to the degree of decomposition of the plant debris. In considering the ecology of New Zealand

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earthworms, four of Kubiena's humus types appear to be significant, as follows:

Mull: Found occasionally under broadleaved forest, only in very favourable conditons.

Mull-like moder: The common humus type of broadleaved forest. Fairly common under podocarp forest.

Moder: The common humus type of podocarp forest. Found under beech forest in warmer areas, but in colder areas beech tends to give raw humus.

Raw humus (mor): Under beech in cooler areas, pine forests, manuka scrub. Well developed under kauri forest.

In the extreme case of raw humus conditions, under kauri, there is usually a very restricted leaf mould fauna consisting of species that are not found under mull-forming trees; topsoil and subsoil earthworms are very rare or are absent. In mixed podocarp-kauri or kauri-broadleaved forests, which are found in North Auckland, the earthworm fauna sometimes varies from tree to tree.

Under native scrub, the earthworm fauna is generally similar to that of the raw-humus-forming forest soil, but with a tendency to lower population density and fewer species. Native scrub is found where the climate is too dry or too cold or the soil too poor to support forest. These conditions also restrict the distribution and activities of earthworms, and their effect is further increased by the smaller quantities of leaf mould available from scrub plants than forest plants and the woody nature and apparent unpalatability of much of the leaf mould commonly found under scrub.

New Zealand tussock grasslands have no well defined characteristic earthworm fauna. Almost without exception, the species found under tussocks are found also in nearby soils under forest or scrub. Probable reasons for the lack of a well defined tussock grassland fauna have been discussed previously (see discussion of distribution in areas D and F, p. 407).

Extensive plantations of exotic trees (conifers) provide leaf mould of a fairly uniform constitution and continuous distribution. Consequently, earthworms which are able to adapt themselves to the conditions in exotic forests spread through plantations, which, especially in area D, are very extensive. The effect of exotic plantations on the distribution of earthworms in area D has been described in the discussion of earthworms in yellow-brown pumice soils (p. 436).

Great changes in the earthworm fauna follow the clearing of native vegetation and its replacement by crops or pastures with grazing animals. Endemic earthworms decline very rapidly in numbers and variety and may entirely disappear; eventually their place is taken by introduced lumbricids. The leaf mould fauna is eliminated since there is no longer a supply of leaf mould; the topsoil fauna is usually eliminated, but occasionally persists in a very reduced condition; the subsoil fauna may remain, relatively unaffected, although if the soil is continually cultivated, it does not survive. Following clearing, there appears to be an interval, during which pastures or crops are becoming established and residues of leaf mould from the original vegetation are still recognisable on the soil surface, when there is little further change from the condition of a depleted endemic fauna or a complete absence of earthworms. The duration of this interval is variable and is related

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to the level of fertility of the soil, availability of a population of lumbricid earthworms adjacent to the cleared area to provide a stock to populate the cleared area, size of the area cleared and consequently time required for the spread of lumbricid worms within the area, and other factors which affect the individual case, such as the slow spread and increase in numbers of lumbricid worms in soils derived from pumice deposits, due to the course texture and low clay content of such soils.

The initial changes after burning of scrub and its replacement by pasture grasses have been described for Taita silt loam, hill soil (soil set 41aH, N.Z. Soil Bureau, 1954), in a previous paper (Miller *et al.*, 1955). Ten months after the land was cleared and sown, the soils were only sparsely populated by representatives of the former endemic fauna and no lumbricids could be found. The whole process of replacement of endemic by exotic species when native vegetation is removed and replaced by pasture is well illustrated in yellow-brown pumice soils and has been described in the discussion of that soil group (see p. 435).

Since endemic Megascolecidae are rarely found in the topsoil of pastures or cultivated land, and Lumbricidae are rarely found except in these conditions, there is no direct competition between endemic Megascolecidae and exotic Lumbricidae. One exotic megascolecid (*Pheretima peregrina*) is found in the topsoil of pastures in the warmer parts of the North Island, living with introduced lumbricids. This species seems able to maintain itself even in a pasture with a very high lumbricid population. In the few cases where endemic megascolecids have been found in pasture topsoil, there are few or no lumbricids and pasture fertility is very low.

The Activities of Earthworms in Soil

The activities of earthworms in the soil, as they affect the nature and development of the soil, may be divided into two categories, as follows:

1. The ingestion of mineral soils and dead plant remains, the partial degradation of organic material and the subsequent excretion of intimately mixed mineral organic matter as castings.
2. The construction of burrows.

Birch and Clark (1953) classified soil-dwelling animals into five groups – decomposers of plant litter (this group includes earthworms as one of its most important agents), bacterial, algal, and fungal feeders, and predators. Kubiena (1955) considered that the activity of soil animals has such a decisive influence on the composition and structure of the humus horizons that it must be considered to be the most important criterion for the definition and classification of the different humus forms. The principal agents of humification, and consequently the most important group in the determination of humus forms, are the decomposers of plant litter. The other four groups (of Birch and Clark) contribute only faeces and breakdown products of their dead bodies to humus.

Earthworms feed on soil organic matter, much of which is obtained from dead plant remains and animal excreta at or near the soil surface and the remainder by ingestion of soil. Waters (1955) has shown that in a New Zealand pasture *Allolobophora caliginosa* and *Lumbricus rubellus* feed principally on dead plant roots and, to a lesser extent, on dead herbage and sheep dung. By removing dead root material, earthworms promote the aeration of surface soil and stimulate the

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growth of pasture plants. At the same time, their castings provide a layer of organically enriched soil in which perennial grasses and clovers are able to re-root year by year. Most endemic Megascolecidae depend upon a supply of leaf mould for their food, as is evident from the rapid decline of leaf mould and topsoil species when forest is replaced by pasture. The alimentary canal of large endemic subsoil species is usually filled with soil; their ability to live on the organic matter contained in soil may account for their survival under exotic pastures, in contrast to the leaf mould and topsoil species, which cannot survive the cessation of supply of forest litter, and the low organic matter content of their food compared with that of the leaf mould feeding species may account for their sluggishness in comparison with other species.

The quantity of soil deposited at the soil surface in the form of worm casts has been estimated many times. Evans (1948), on eight fields of differing history, found that the weight of surface castings ranged from one to twenty-five tons per acre per year. Most species do not cast at the surface, but in deserted burrows, cracks and spaces between soil particles. In the fields studied by Evans, only *Allolobophora terrestris* f. *longa* and *Allolobophora nocturna* were surface casting species. Calculations based on total populations and taking some account of species that cast beneath the soil surface, showed that from four to thirty-six tons of soil per acre per year passed through the alimentary systems of earthworms and was cast at or beneath the surface. Three of the common lumbricids of New Zealand pastures, *Allolobophora caliginosa, A. terrestris* f. *longa,* and *Lumbricus rubellus* are surface-casting species. *A. caliginosa* also casts beneath the soil surface and so, probably, do all other so-called surface-casting species.

Three specimens of *Octochaetus multiporus,* kept under observation for a year in a thin monolith of Taita heavy silt loam (soil set 41aH, N.Z. Soil Bureau, 1954) 24 in. long, 16 in. deep and ½ in. thick, produced a four inch thick, spongy surface layer of castings, containing humus, topsoil and subsoil. Topsoil and humus were also cast in cavities in the subsoil and the whole profile was considerably altered. In this experiment the effect of earthworms on the soil was separated from factors such as the impact of rain drops, movement of surface water, frost and trampling, which under field conditions break down the castings as the earthworms build them up, so that an equilibrium becomes established between deposition and breakdown.

Measurements of the resistance to disintegration of aggregates formed from worm casts have produced conflicting results. The work of Dawson (1947) showed that stable aggregates with low bacterial populations are produced in the earthworm's alimentary canal, but after the aggregates are deposited as castings there is an increase in bacterial numbers, accompanied by a decrease in stability. The time elapsing between the deposition and collection of castings for study would therefore affect the results obtained from the study. This may account for the conflict of opinion on the stability of castings. It would also be expected that there would be some variation in the stability of aggregates according to variations in the physical nature and organic matter content of ingested material.

Taylor (1955) has drawn attention to problems arising from the casting activities of large populations of introduced lumbricids in highly fertile pastures. The addition of fertilisers is followed by

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increased pasture growth and increased earthworm populations producing large quantities of castings on the surface, burying the crowns of pasture plants. High density of grazing animals on such highly productive pastures leads to the trampling and breakdown of worm casts, giving rise to "poaching" and to a decrease in bearing strength of the superficial soil layers. Measurements near Auckland showed that there was a build up of about $^1/_{10}$ inch of cast material each year. This contrasts with the figure of four inches per year obtained under experimental conditons with *Octochaetus multiporus*, and shows the effects of factors operating under field conditions, which were absent in that experiment.

An extreme case of loss of bearing strength and poaching of the soil surface occurred on Hauraki Plains for a number of years up to 1940. N. H. Taylor (pers. comm.) observed very high earthworm populations, concentrated near the surface, in slightly raised patches of high producing pastures. The hoofs of animals sank deeply into thick accumulations of worm casts. Farmers stated that the earthworms had been very numerous for several years and seemed to be increasing year by year. It seems most likely that there must have been a number of years that were especially favourable for earthworms, coinciding with an increase in pasture fertility due to increasing use of fertilisers and consequently a higher density of stocking with grazing animals. The initial effect was to produce mechanical breakdown of the surface layers of the soil, but, as the pasture developed further, the strength of the turf apparently increased, or perhaps the earthworm population decreased, as there is no longer such a serious problem.

The chemical composition of earthworm casts has been examined by a number of workers. Lunt and Jacobson (1944) concluded that under pastures worm casts were less acid, higher in total and nitrate nitrogen, organic matter, total and exchangeable calcium, exchangeable potassium and magnesium, available phosphate, base exchange capacity and base saturation than the undisturbed soil, while under forest, nitrogen, organic carbon and exchangeable calcium figures were higher than under pasture on the same soil. They considered the differences to be due mainly to intimate mixing of plant and animal remains with mineral soil in the digestive tract and to the action of digestive secretions on the mixture. The results obtained by Lunt and Jacobson would apply only to the particular set of environmental conditions investigated by these workers, and would not necessarily apply to any other set of conditions, but they may be taken as a general indication of the changes resulting from the passage of soil through the alimentary canal of earthworms.

Earthworms are the largest and most numerous burrowing animals in New Zealand soils. They have two distinct methods of making burrows. Soil is swallowed and subsequently cast at the soil surface or in natural cracks and cavities in the soil or in deserted earthworm burrows, or the anterior end of the body is extended and inserted into cracks or spaces between soil particles and then by contraction of the longitudinal muscles the body is expanded laterally, compressing the soil, to form a burrow to accommodate the earthworm's body. Usually burrowing consists of a combination of these two methods, the former predominating in more compact soils and the latter in less compact soils. As a burrow is formed, it is lined with slime produced by epidermal gland cells and thus has smooth walls, firmly compacted by the lateral pressure applied by the earthworm during its construction.

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The extent and type of burrows constructed by New Zealand earthworms vary according to the ecological preferences of the individual species. Leaf mould earthworms do not construct burrows but move freely in the loose material that constitutes their environmental medium, just as arthropods and other leaf mould animals do. Where species typically found in leaf mould are living under stones or logs they may be found in tunnels with the stone or log acting as a roof. Topsoil species in general make shallow burrows in which they pass most of the time, emerging on the surface to forage for food, which they take back into their burrows, or to mate. Most species appear to continue active burrowing outside the confines of their living space, and apparently they live to some extent on food obtained by ingestion of soil and digestion of organic matter contained in it. Subsoil earthworms make very extensive burrows, extending laterally and vertically in the subsoil, and occasionally going up into the topsoil. These burrows appear to be made to obtain food by ingestion of soil and not primarily for shelter, like the burrows of topsoil species. As they move forward in their burrows, they may deposit castings in the section of the burrow left behind, so it is not uncommon to find burrows of subsoil earthworms partly filled with castings obviously derived from the subsoil. Subsoil species are usually of large size and they make very wide burrows, which may descend several feet into the soil. A. C. S. Wright (pers. comm.) found burrows of *Spenceriella gigantea* still continuing downwards at a depth of 11 ft. 6 in., on Little Barrier Island.

In many New Zealand soils, worm burrows, particularly those of large subsoil species, are prominent features of the soil profile. Disused burrows in the subsoil become filled with castings and humus stained material washed in from the topsoil, giving rise to "worm mottling". Soils inhabited by *Octochaetus multiporus,* a large subsoil species found throughout much of the South Island and southern North Island, have, as a common characteristic, worm mottled subsoils. Subsoil earthworms are most commonly found in heavy textured soils. The walls of their burrows are tightly compacted and retain their form long after they are deserted. Once filled with humus stained topsoil material they become permanent features of the profile. The disused burrows of topsoil species give rise to worm mottling, which may be very extensive, but it is not usually as obvious as mottling due to subsoil worm burrows, since there is often no great contrast between the colours of the mottled materials and the in-filled burrows are of smaller diameter than those of large subsoil species.

The burrows of earthworms provide channels for water to move quickly through the soil. In subsoils with high clay content, subsurface movement of water down slopes must be assisted by the extensive burrows of large subsoil species. Red, iron-stained deposits found on the walls of old burrows indicate that they are channels for the downward movement of water containing mineral materials leached from the overlying soil horizons. Small plant roots have been observed to follow deserted worm burrows and the burrows must facilitate the growth of deep rooting plants.

The lumbricid species of New Zealand pasture lands are all topsoil dwellers. Their activities are usually confined to the top one or two inches, but in the summer if the surface soil becomes too dry for them they retreat into the subsoil and go into diapause. The vertical channels made by worms in these circumstances remain for a short time as

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channels for the passage of water down through the soil but their walls are not usually firmly compacted and they soon collapse.

TIME

The stage in soil development at which earthworms can become established varies with the conditions in individual cases and depends upon the availability of species able to live in those conditions. Earthworms live in pieces of wood, under stones, in water, on beaches, so they need not have a soil to live in and may possibly be present at the commencement of a soil forming process, e.g. when a sand dune first becomes stabilised and soil formation commences on it. When, as is probably more usual, earthworms are not present at the inception of soil formation, their time of entry and subsequent progress are related to the stage of soil development.

For earthworms to become established in a soil, there must be an organic cycle in operation and it must provide a constant supply of plant debris of a type suitable for earthworms to feed on. In addition, all the other essential requirements for the existence of earthworms must be satisfied, at least in spaces large enough for the earthworm to pass most of the time. There must also be, at the particular time and place, some species capable of colonising the developing soil. This latter point is of some importance; in saline soils in New Zealand there is often no earthworm fauna, yet species capable of living in saline soils are known in New Zealand, e.g. *Rhododrilus cockaynei*. The discontinuity of areas with suitable saline soils prevents the species from becoming established in many places where, once established, there is no apparent reason why it should not be successful. Conditions suitable for earthworms of some kind are almost universally available wherever plants grow. Earthworms are therefore very widely distributed and it is very rare to find a site with vegetation that lacks earthworms, even where the vegetation consists only of mosses and lichens.

The coarse physical texture and weakly weathered nature of yellow-brown pumice soils and the discontinuity of plant cover often found on these soils have markedly affected the distribution and ecology of earthworms. These factors are attributable to the short time that has elapsed since the parent material was deposited and soil forming processes began to operate. The effect on earthworms is not directly due to the youth of the soils, but is due to the effect of the youth of the soils on other environmental factors.

In general it is true that earthworms are present from the beginning of, or very early in, the soil forming process. A soil may occasionally develop for some time without any earthworms, but this would be due to some obvious inhibitory factor (e.g. high salinity or high water table), or to the absence in adjacent soils of earthworms able to colonise the developing soil, or to a physical barrier to the dispersal of earthworms.

At the other end of the time scale, in strongly leached soils, earthworms tend to be less numerous than in moderately leached soils and their distribution in the soil horizons differs from that of moderately leached soils. Examples of the changes that take place in a sequence of related soils have been described previously (e.g. on p. 433, p. 437).

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ECOLOGICAL SPECIATION

Geographical barriers, past and present, and recent climatic changes have been most important in defining the major faunal districts of New Zealand so far as earthworms are concerned. Abundant evidence is contained in this work, however, to show that, within the major faunal areas, the high degree of ecological specialisation characteristic of New Zealand Megascolecidae has been responsible in most cases for the physiological isolation of the large number of species that have been recorded.

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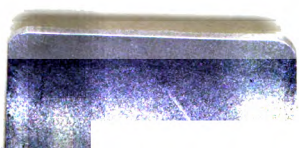

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